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SMALL SCIENTIFIC SATELLITE
SSS-A

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GREENBELT, MARYLAND

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
GODDARD SPACE FLIGHT CENTER
GREENBELT, MARYLAND

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NASA-GSFC
OPPLAN 8-71

SMALL SCIENTIFIC SATELLITE
(SSS-A)

The purpose of this Operations Plan is to provide information for the activities concerned and to serve as a guide during operations. Amendments will be issued as necessary.

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NASA-GSFC
OPPLAN 8-71

SMALL SCIENTIFIC SATELLITE
(SSS-A)

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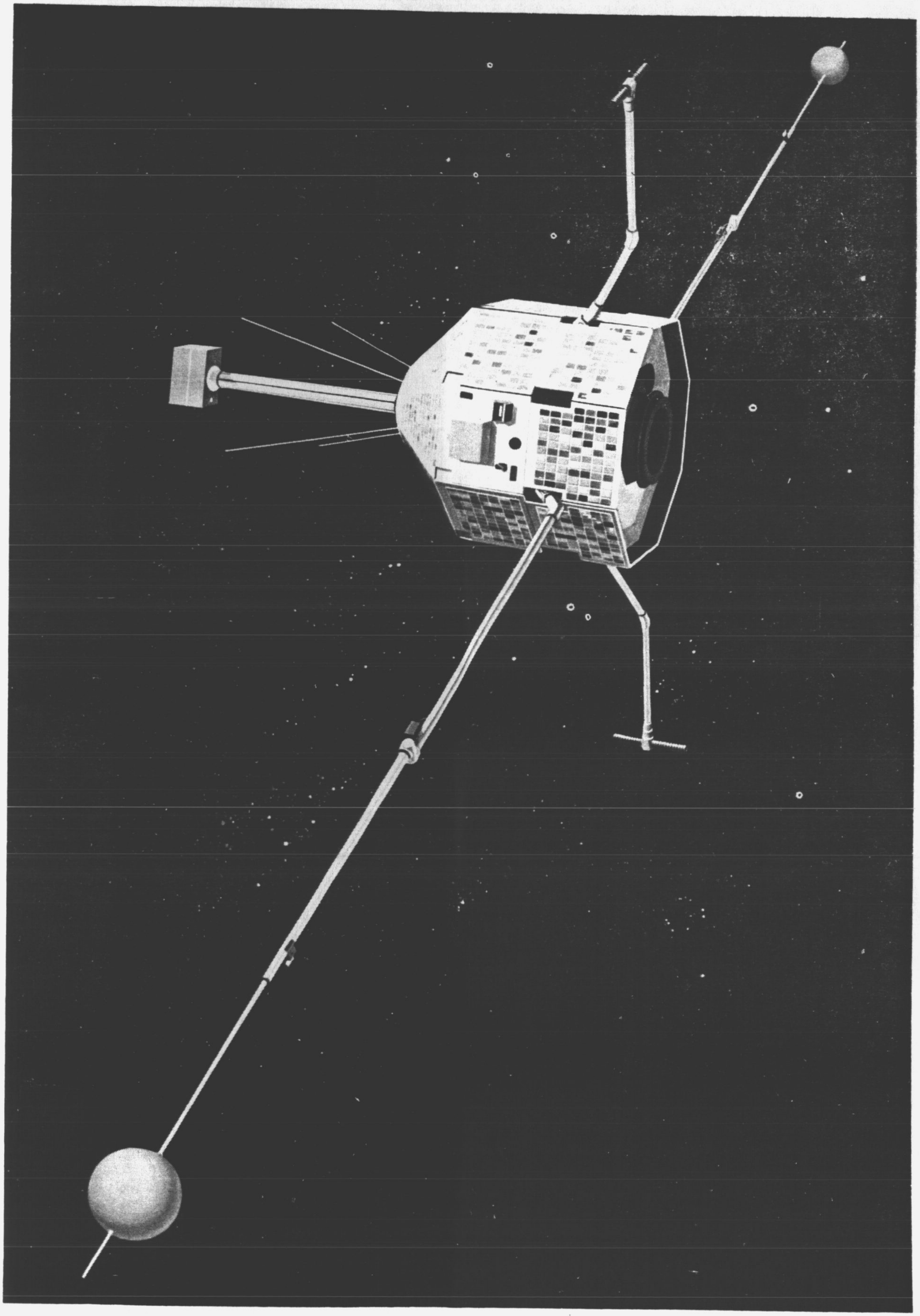


Small Scientific Satellite

SECTION 1

MISSION IMPLEMENTATION

SECTION 1
MISSION IMPLEMENTATION

1.1 MISSION OBJECTIVES

The Small Scientific Satellite (SSS-A) will be launched into an elliptical, equatorial orbit to study the dynamic processes in the inner magnetosphere near the magnetic equator.

The specific scientific objectives for this mission are as follows:

a. Investigating the activities of low-energy particles in the ring current and development of the main phase magnetic storm.

b. Investigating the relationship between auroral phenomena, magnetic storms, and the acceleration of charged particles within the inner magnetosphere.

c. Measuring the variations of the trapped-particle population.

d. Measuring the directional intensities of 0.5- to 1000-kev protons and electrons with an energy resolution factor of about 2.

e. Measuring the vector magnetic field from 0 to 10 Hz in a field strength up to 3000 gammas.

f. Measuring the magnetic fluctuations greater than 0.001 gamma over the range 1 to 3000 Hz.

g. Measuring the complete spectrum of electric fields from dc to 200 kHz.

1.2 MISSION DESCRIPTION

The SSS-A mission requires a low-inclination, elliptical orbit with an apogee of at least 5 earth radii geocentric, and a minimum orbital life of 6 months. To meet these requirements, the spacecraft will be launched by a four-stage Scout launch vehicle from the Italian San Marco launch platform which is located about 3 miles off the coast of Kenya, South Africa, in the Formosa Bay. The subsatellite plot through the first orbit is shown in Figure 1-1.

The planned orbital parameters are as follows:

a. Height of apogee . . . . 28,877 km

b. Height of perigee . . . . 222 km

c. Eccentricity 0.6846

d. Inclination . . . . 3.43 deg

e. Anomalistic period . . . . . . 502.2 min

The following GSFC Spaceflight Tracking and Data Network (STDN) stations will be scheduled for tracking, command, and data acquisition support:

a. Canberra, Australia (ORORAL)

b. Carnarvon, Australia (CARVON)*

c. Fairbanks, Alaska (ALASKA)**

d. Fort Myers, Florida (FTMYRS)

e. Johannesburg, South Africa (JOBURG)

f. Quito, Ecuador (QUITOE)

g. Rosman, North Carolina (ROSMAN)**

h. Santiago, Chile (SNTAGO)

i. Seychelles, Mahe (SEYCHL)*

j. Tananarive, Madagascar (MADGAR)

k. Winkfield, England (WNKFLD)

Spacecraft operations during the mission are divided into two parts: initial spacecraft operations and normal spacecraft operations.

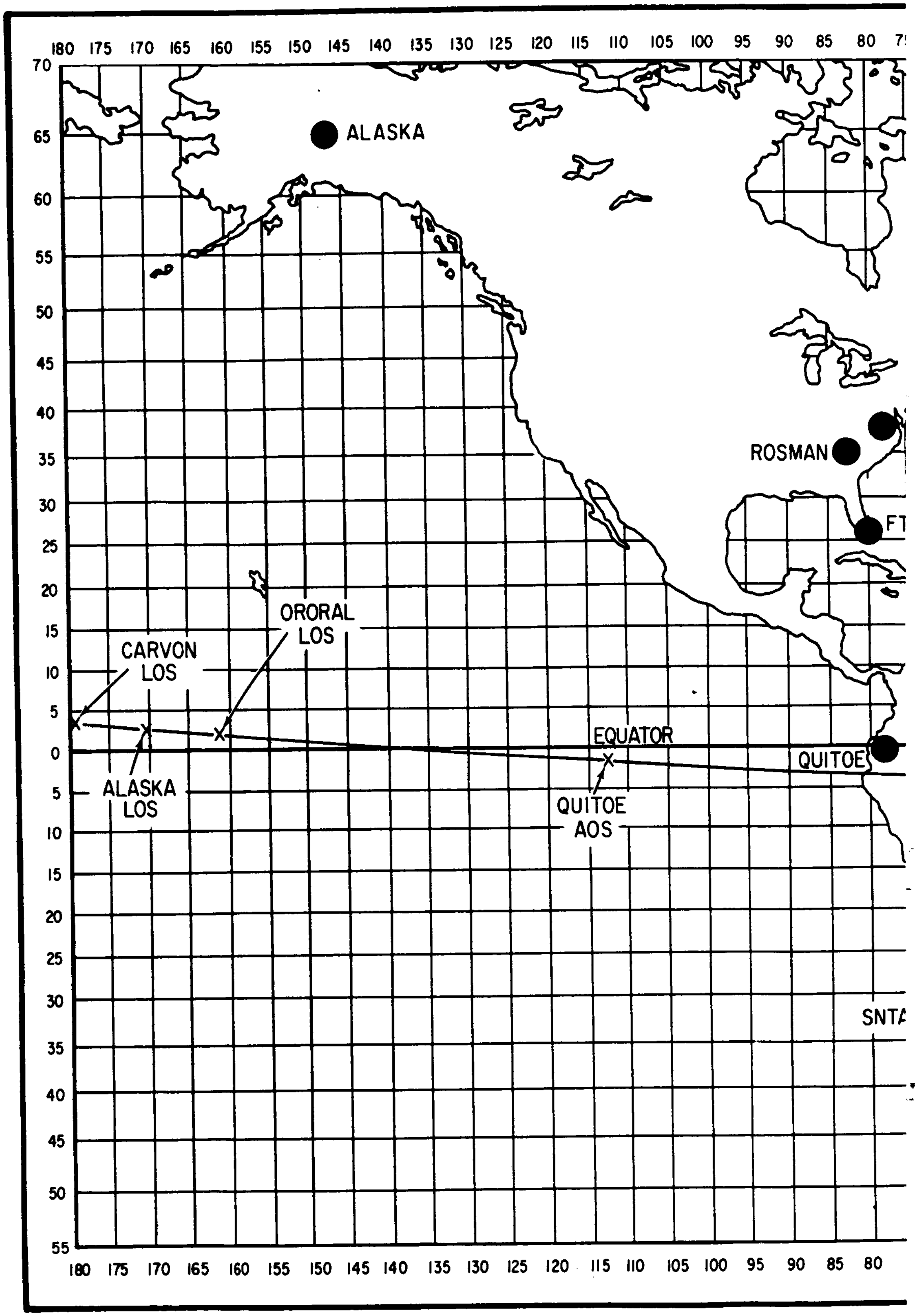
1.2.1 INITIAL SPACECRAFT OPERATIONS

This part of the mission begins at lift-off and lasts for the first few days after launch. It is divided into two overlapping phases; the launch and early-orbit phase and the checkout and experiment activation phase.

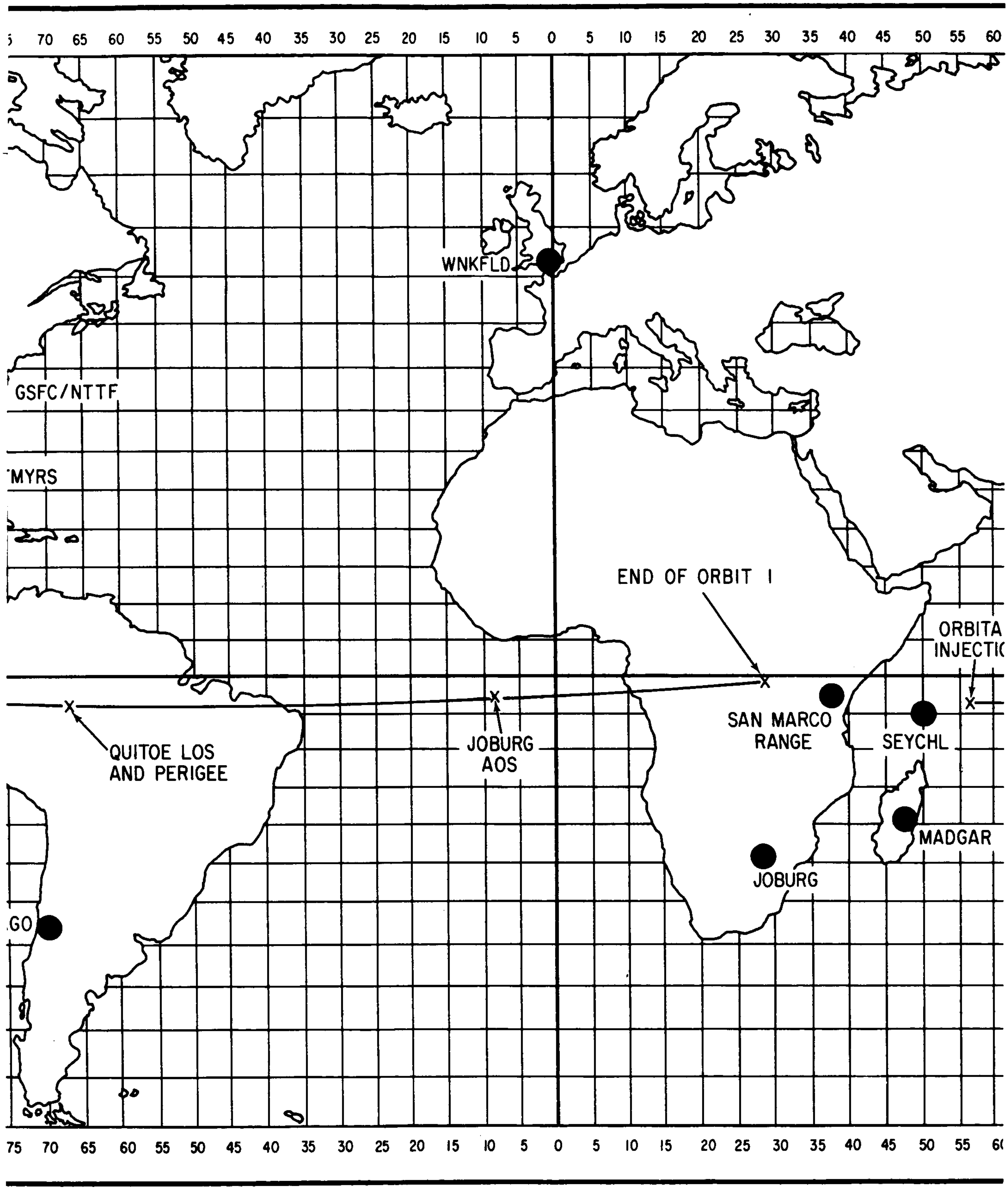
1.2.1.1 Launch and Early-orbit Phase

This phase begins at lift-off and covers the acquisition of initial tracking data for orbit determination. Facilties at the San Marco Range will radar track the launch vehicle from launch to third stage burnout. The flight sequence of events is listed in Table 1-1.

*Launch phase telemetry support only. **Command and data acquisition support only.



ALASKA
ROSMAN
QUITOE
SNTA
CARVON
LOS
ORORAL
LOS
ALASKA
LOS
EQUATOR
QUITOE
AOS



WNKFLD
GSFC/NTTF
MYRS
END OF ORBIT I
ORBITA
INJECTI
QUITOE LOS
AND PERIGEE
JOBURG
AOS
SAN MARCO
RANGE
SEYCHL
MADGAR
JOBURG
GO

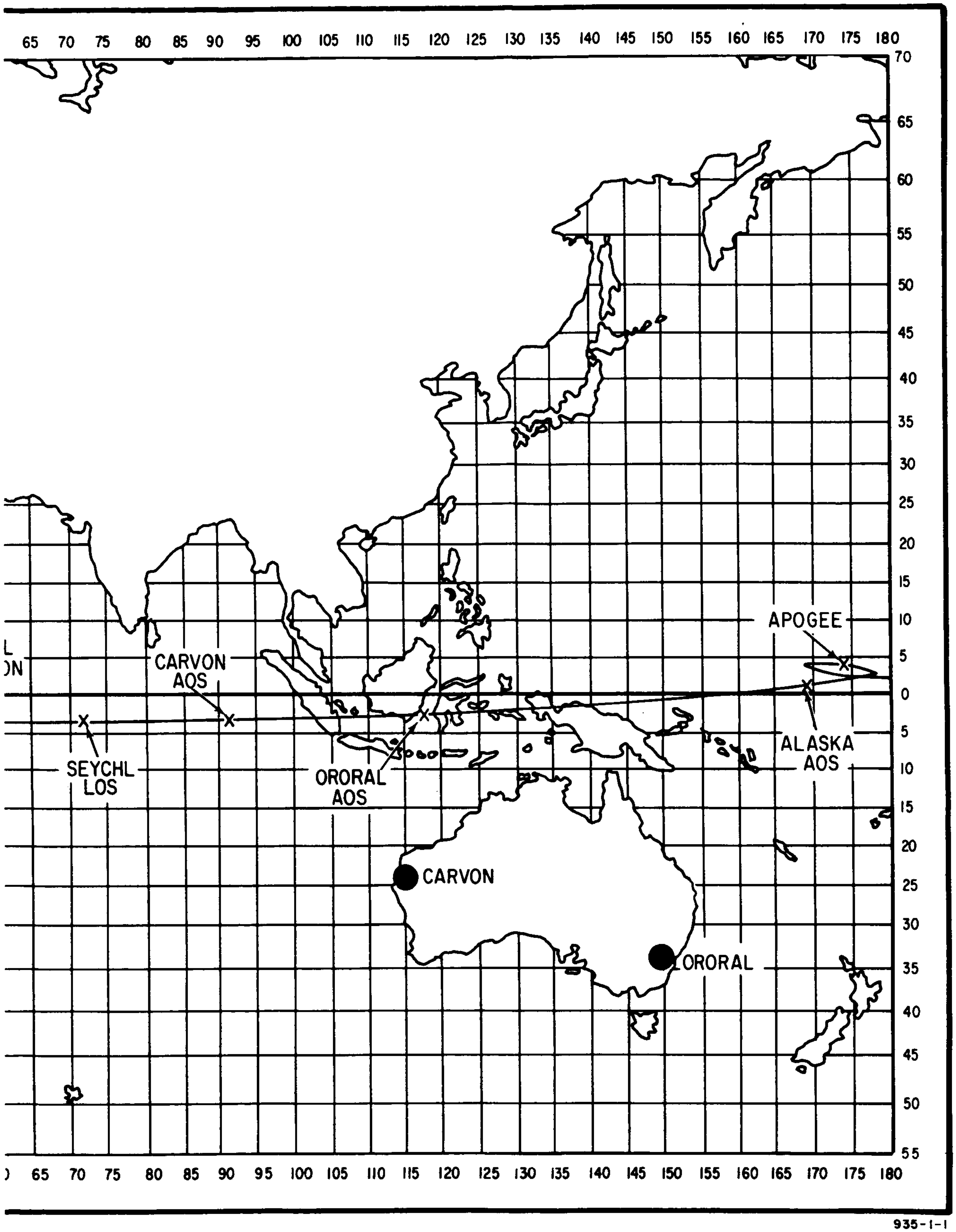


Figure 1-1. SSS-A Subsatellite Plot

Table 1-1. Flight Sequence of Events

Step	Event	Time (Seconds)
1	Lift-off	T+0.0
2	First stage burnout	T+77.1
3	Second stage ignition	T+80.8
4	Second stage burnout	T+121.7
5	Heat shield ejection	T+159.8
6	Third stage ignition	T+161.5
7	Third stage burnout	T+198.2
8	Spin up	T+ ≈ 430
9	Fourth stage ignition	T+436.5
10	Fourth stage burnout	T+472.6
11	Separation	T+965.00
12	Despin (yo-yo release)	T+970.00
13	Boom extended	T+972.00

The North American Air Defense Command (NORAD) will be requested to provide tracking support for the SSS-A mission during the first 24 hours after launch. If requested, the acquired tracking data will be transmitted to GSFC via teletype.

The STDN stations will begin scheduled tracking operations as soon as possible after launch to provide tracking data for orbit determination. The launch and early-orbit phase ends and normal tracking operations begin when the orbit has been determined and updated predictions have been sent to the supporting stations.

1.2.1.2 Checkout and Experiment Activation Phase

This phase begins with the acquisition of spacecraft telemetry data as soon as possible after launch. On the first orbit, the STDN station at Canberra, Australia (ORORAL), will acquire real-time data and will transmit them via DTS to GSFC for spacecraft checkout and attitude determination. Appendix C contains a complete description of expected spacecraft activities during the first few orbits after launch. Spacecraft checkout and experiment activation will be completed with the first turn-on of SCADS, which should occur at approximately the tenth orbit, and the turn-on of the channeltron, which should occur about 6 days after launch.

1.2.2 NORMAL SPACECRAFT OPERATIONS

This phase will begin within the first week after launch and will last for the duration of the mission. Generally, selected STDN stations will acquire real-time PCM and wideband telemetry data and will send the necessary commands when the spacecraft is beyond 2 earth radii geocentric (i.e., beyond altitudes of approximately 6,400 kilometers). The mission scheduling criteria in paragraph 3.4, and the command operations in paragraph 4.3, provide an indication of the expected activities during the normal phase of operation.

1.3 LAUNCH VEHICLE

The launch vehicle for the SSS-A is the four-stage Scout launch vehicle which is shown in Figure 1-2. Launch vehicle parameters are listed in Table 1-2.

The Scout launch vehicle will place the following objects into orbit:

a. SSS-A spacecraft

b. Fourth stage UTC FW-4S rocket motor with attached fittings; dimensions are as follows:

(1) Length . . . . 62 in.

(2) Diameter . . . . 20 in.

(3) Weight . . . . 73 lb

c. Yo-yo mechanism (two 72 gram weights, 1 by 1 by 0.5 inch, each attached to a 14.75 foot cable).

1.4 SPACECRAFT DESCRIPTION

The main body of the spacecraft is octagonal in shape with three major structural assemblies plus five external appendages. Solar panels are mounted on the exterior of the lower, middle, and upper structural assemblies. The fluxgate magnetometer boom extends about 30 inches from the upper section when fully deployed. Two single-hinged booms support search coil magnetometers and two double-hinged booms support the electric field detector spheres. Total spacecraft weight is approximately 108 pounds. The spacecraft and its dimensions are shown in Figure 1-3.

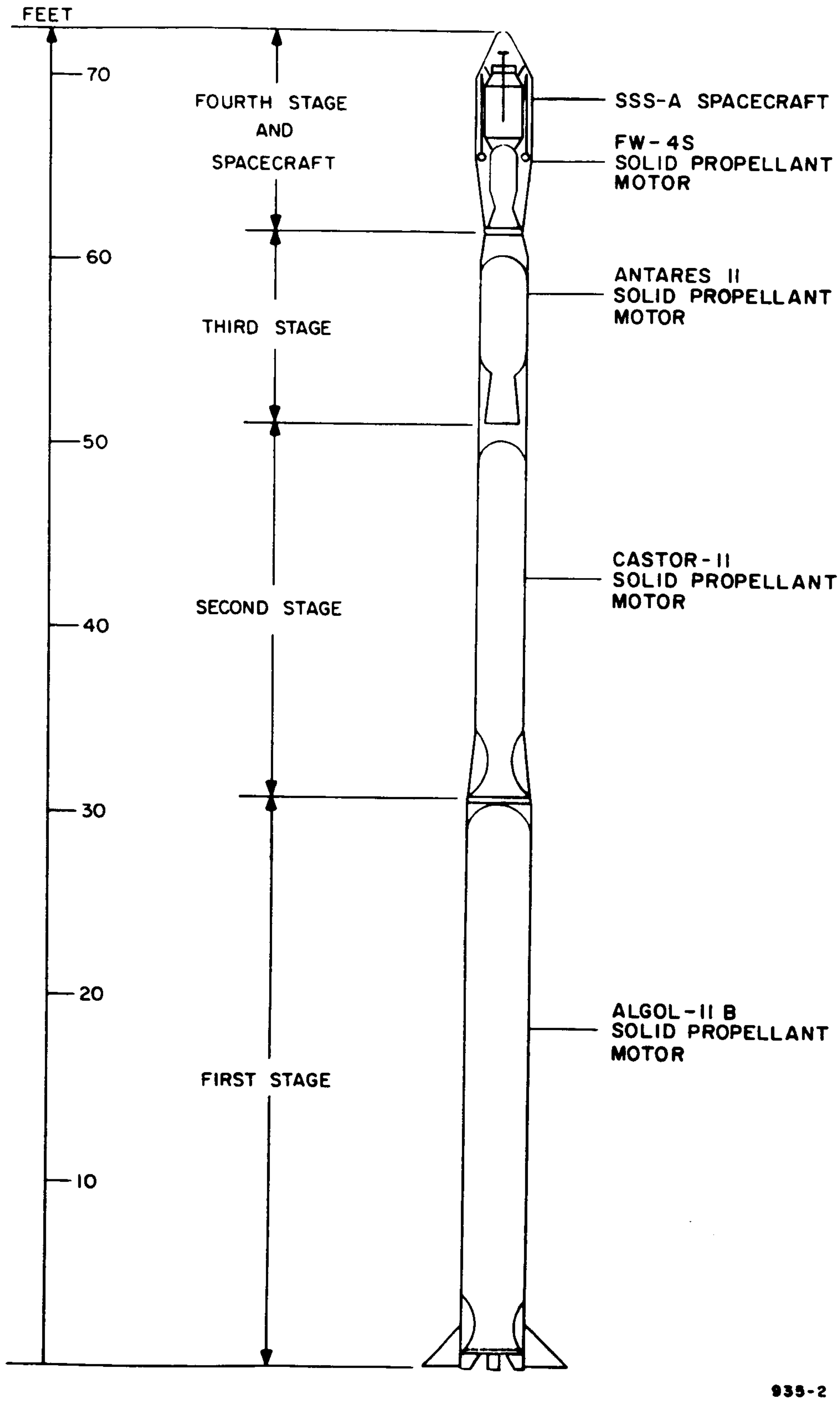


Figure 1-2. Scout Launch Vehicle

Table 1-2. Scout Launch Vehicle Data

Name	Algol II B	Castor II (TX-354-3)	Antares II (X259-B3)	FW-4S (XSR-57-UT-1)
Stage	1	2	3	4
Thrust (lb)	98,470	61,839	20,931	5,857
Propellant	Solid	Solid	Solid	Solid
Fuel weight (lb)	21,176	8,212	2,575	606
Gross weight (lb)	23,800	9,760	2,812	664
Control	Aerodynamic tip and jet vanes	Reaction thrust	Reaction thrust	Spin-stabilized
Guidance	—	—	Strapped-down inertial system	—
Tracking aids	—	—	C-band beacon	—
All data are nominal and were taken from the Scout User's Manual.				

1.5 ELECTRONIC SYSTEM DESCRIPTION

The spacecraft electronic system, shown in Figure 1-4, includes the telemetry, command, and data handling subsystem, and power source consisting of a battery and solar cells (panels).

1.5.1 TELEMETRY SUBSYSTEM

The spacecraft-to-earth telemetry subsystem has two links with three modes of operation. The spacecraft telemetry subsystem employs two transmitters, operating on different frequencies, for the transmission of data. The primary link transmitter is used for the transmission of PCM telemetry data. The telemetry transmission from the primary transmitter of the spacecraft is also the signal used for tracking by the ground stations. The second transmitter is used for the transmission of the experiment analog data and as a backup for the transmission of the PCM data normally handled by the low-power transmitter. The secondary transmitter may also serve as a tracking beacon. The duty cycle of the primary transmitter will be continuous while the secondary transmitter will be utilized on an average of about one orbit out of ten depending upon the available power.

The primary and secondary telemetry links are presented in the following paragraphs.

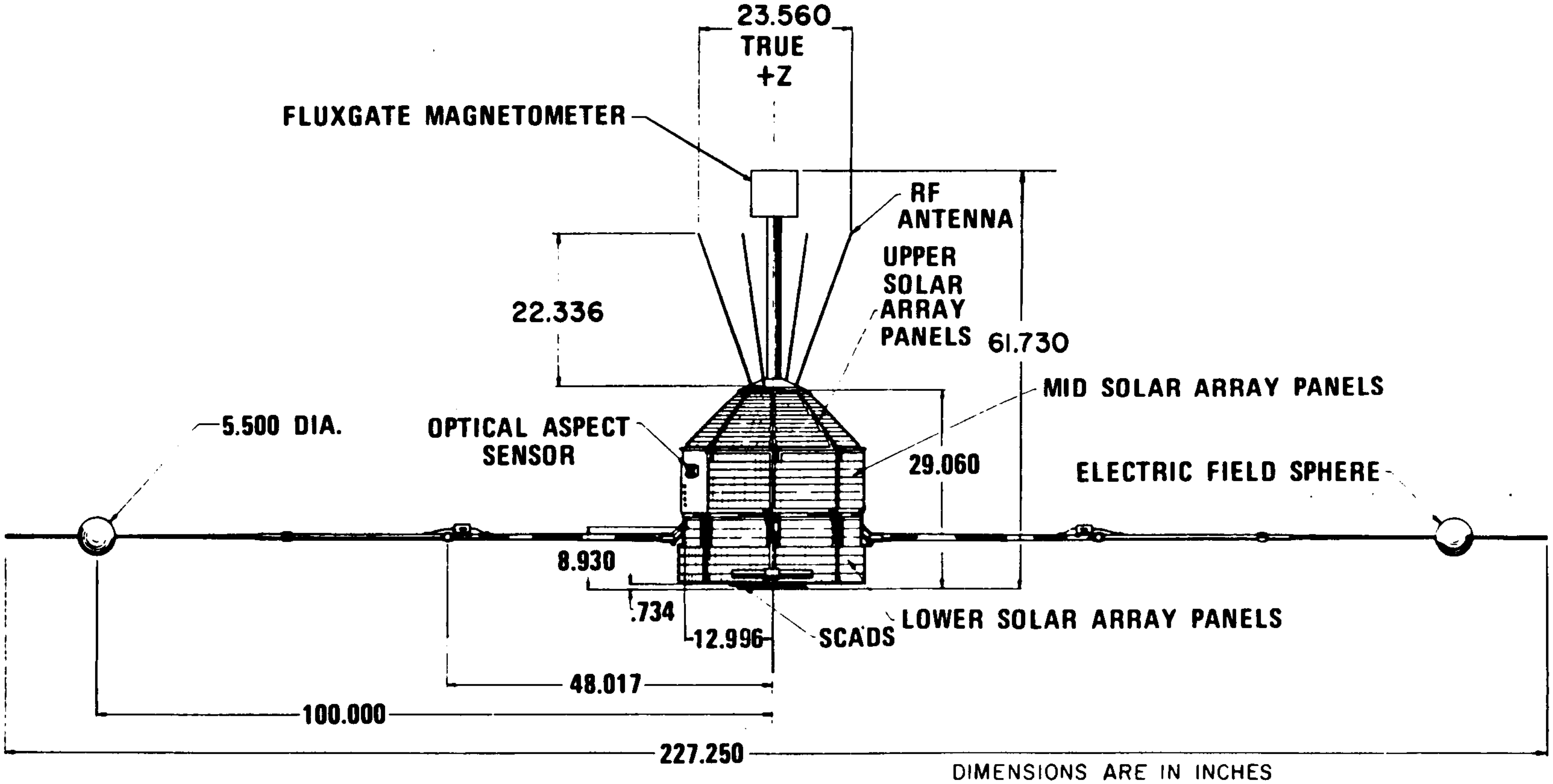


Figure 1-3. SSS-A Spacecraft

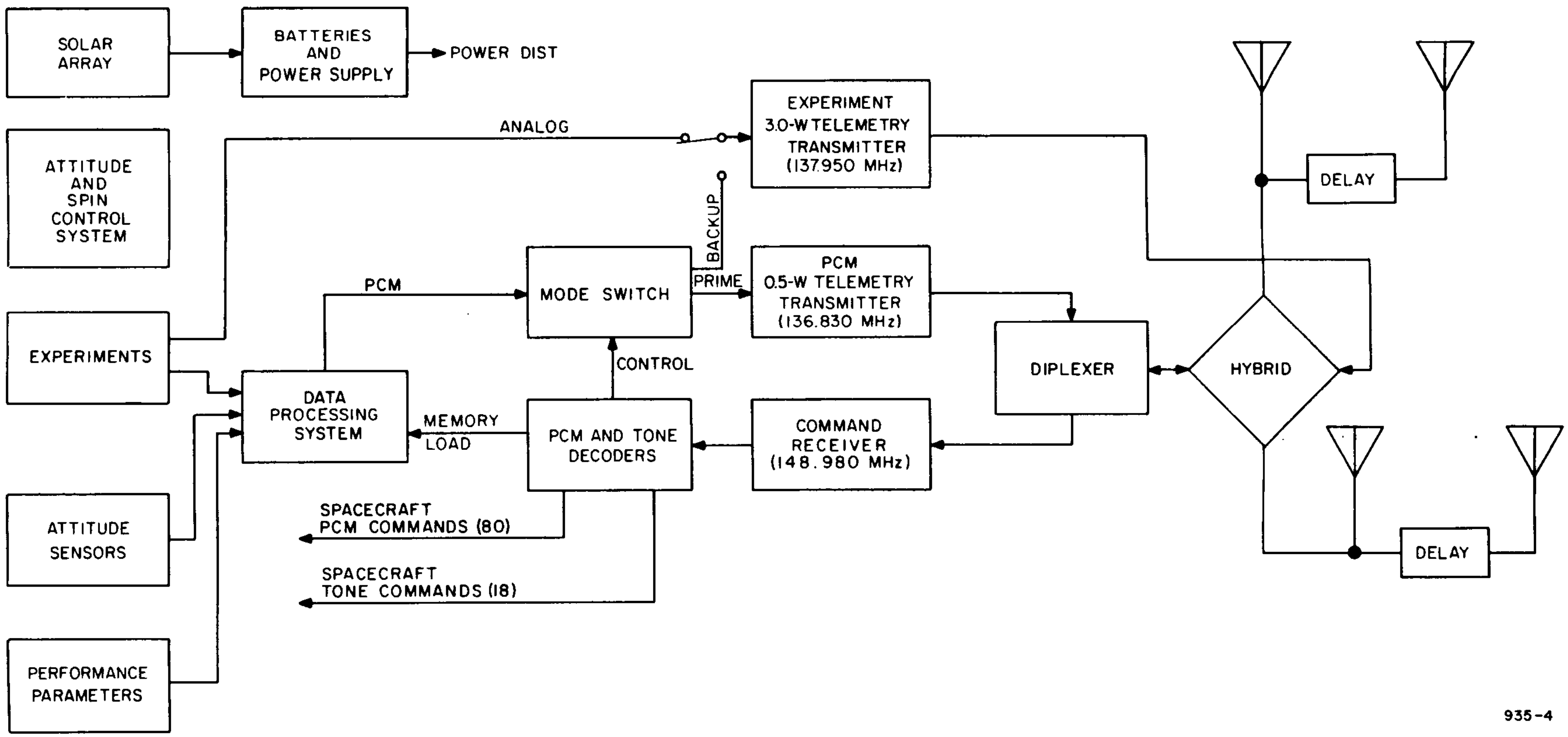


Figure 1-4. SSS-A Spacecraft Electronic System, Block Diagram

1.5.1.1 Primary Telemetry Link

The low-power PCM transmitter is the primary telemetry link and operates on a frequency of 136.830 MHz with an output power of 0.5 watt. The PCM (split-phase)/PM telemetry at a bit rate of 446 bps will be continuously radiated.

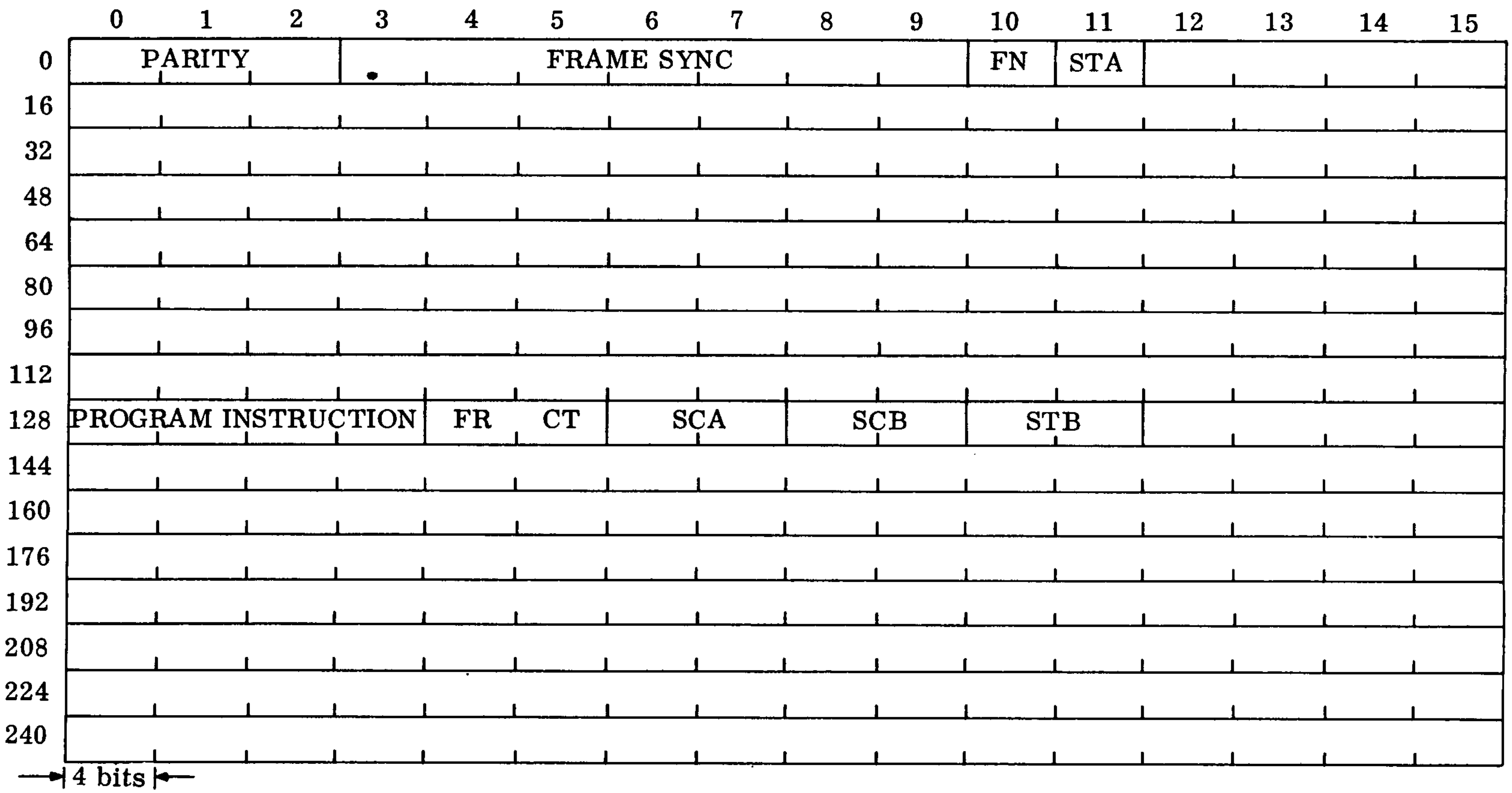
The spacecraft data processing system (DPS) allows the telemetry format to be programmed from the ground. One PCM telemetry main frame (real-time digital data) contains 1024 bits and can have three different formats.

The telemetry main frame format of the SSS-A spacecraft, when in the data mode, is illustrated in Figure 1-5. Those portions of the format not identified are controlled by the DPS and can be programmed as desired. Each main frame consists of 256 four-bit telemetry words. Subcommutators A and B are read out at a rate of one 8-bit subcommutator word per main frame, as formed from 2 consecutive 4-bit words* Since there are 64 subcommutator words in A and B, 64 main frames are required to obtain all the subcommutator information. This group of 64 main frames is called a subcommutator sequence. In the data mode, 256 main frames (4 subcommutator sequences) are required to obtain a complete readout of the on-board program memory, since the contents of the 256 16-bit program memory instructions (4 words) are obtained at a rate of 1 per main frame. This group of 256 main frames is called a telemetry sequence. Each main frame contains 24 words inserted by the DPS that are considered fixed for the SSS-A mission. These fixed words are listed in Table 1-3.

The telemetry format in the program load mode is illustrated in Figure 1-6. In this mode, all the programmable portions of the telemetry format will contain the contents of the last instructions loaded into the program memory. Subcommutators A and B are read out at a rate of one 8-bit subcommutator word per main frame, as formed from 2 consecutive 4-bit words. Since there are 64 subcommutator words in A and B, 64 main frames are required to obtain all the subcommutator information. This group of 64 main frames is called a subcommutator sequence.

The main frame format, when the spacecraft telemetry subsystem is commanded into the accelerated subcommutator mode (ASM), is illustrated in Figure 1-7. In this mode the programmable portion of the telemetry format is filled with words from subcommutators A and B. Subcommutators A and B are read out at a rate of one 8-bit subcommutator word per main frame, as formed from 2 consecutive 4-bit words.

*Refer to paragraph 4.6.4.1 for the data word definition.



NOTE: Words not identified are programmable.

Parameters

1. Word — 4 bits
2. Main frame — 256 4-bit words
3. Subcommutator sequence — 64 main frames
4. Telemetry sequence — 256 main frames
5. Parity — 12 bits
6. Frame sync — 28 bits (1111010111100101100110000000)
7. Format number (FN) — 4 bits
8. Status (ST) — A = 4 bits, B = 8 bits
9. Program instruction — 16 bits including 2 trailing ZEROs
10. Frame counter (FR CT) — 8 bits (0-255)
11. Subcommutation channel (SC) — 8 bits

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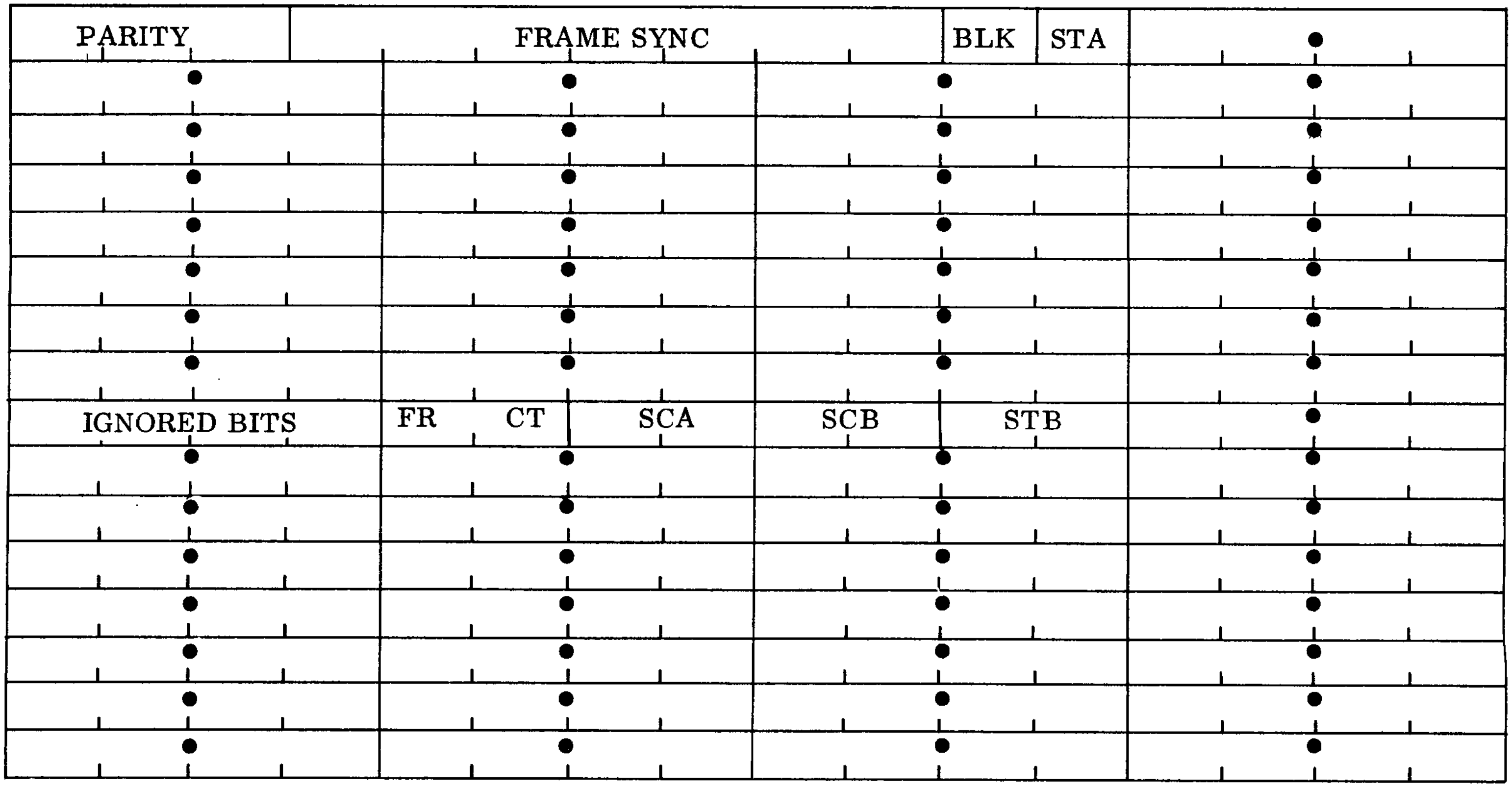
Figure 1-5. SSS-A Telemetry Main Frame Format for the Data Mode

Table 1-3. SSS-A Telemetry Main Frame Fixed Words

Name	Word Location	Description
PARITY	0-2	Parity of preceding main frame words 10 to 255
FRAME SYNC	3-9	The binary pattern 1111 0101 1110 0101 1001 1000 0000
FN	10	The number of the program in the on-board computer. This is changed for each new program
STA*	11	Status bits 1 to 4 as follows: Bit 1 = 0 in the primary mode with the PI and PII program operating during the data mode Bit 1 = 1 in the backup mode with only the PI operating during the data mode Bit 2 = 1 if the DPS is in the accelerated subcommutator mode Bit 3 = 1 if the DPS is in the data mode Bit 4 = 1 if the DPS is in the load and verify mode
PROGRAM INSTRUCTION	128-131	Instruction contents of the on-board computer. This is read out at a rate of one 14-bit instruction word per main frame. These 14 bits are adjusted to the left in these 16 telemetry bits with two ZEROs in the right-most 2 bits
FRAME COUNT	132-133	Count of main frames in a telemetry sequence. The count goes from 0 to 255 where frame count 0 corresponds to program instruction 000 and subcommutators A_1 and B_1
SUBCOM A	134-135	Contents of subcommutator A. This is read out at a rate of one 8-bit subcommutator word per main frame for all 64 frames. Refer to Table 1-4
SUBCOM B	136-137	Contents of subcommutator B. This is read out at a rate of one 8-bit subcommutator word per main frame for all 64 frames. Refer to Table 1-5
STB**	138-139	Status bits of the DPS special conditions including: Bit 5 = 1 SCADS power ON Bit 5 = 0 SCADS power OFF

*Bit four is the first bit transmitted.
**Bit eight is the first bit transmitted.



Parameters

1. Word — 4 bits
2. Main frame — 256 4-bit words
3. Subcommutator sequence — 64 main frames
4. Parity — 12 bits
5. Frame sync — 28 bits (1111010111100101100110000000)
6. BLK — Blank (ignored bits)
7. Status (ST) — A = 4 bits, B = 8 bits
8. Frame counter (FR CT) — 8 bits
9. Subcommutation channel (SC) — 8 bits

●Last instruction read into program memory — 16 bits including 2 trailing ZEROs

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Figure 1-6. SSS-A Telemetry Main ‾ ·ame Format for Program Load Mode

PARITY		FRAME SYNC			FN / STA	NOT USED	
A57	B57	A56	B56	A55	B55	A54	B54
A53	B53	A52	B52	A51	B51	A50	B50
A49	B49	A48	B48	A47	B47	A46	B46
A45	B45	A44	B44	A43	B43	A42	B42
A41	B41	A40	B40	A39	B39	A38	B38
A37	B37	A36	B36	A35	B35	A34	B34
A33	B33	A32	B32	A31	B31	A30	B30
PROGRAM INSTRUCTION		FR CT	SCA	SCB	STB	A29	B29
A28	B28	A27	B27	A26	B26	A25	B25
A24	B24	A23	B23	A22	B22	A21	B21
A20	B20	A19	B19	A18	B18	A17	B17
A16	B16	A15	B15	A14	B14	A13	B13
A12	B12	A11	B11	A10	B10	A9	B9
A8	B8	A7	B7	A6	B6	A5	B5
A4	B4	A3	B3	A2	B2	A1	B1

← 8 bits →

Parameters

1. Word — 4 bits
2. Main frame — 256 4-bit words
3. Subcommutator sequence — 64 main frames
4. Telemetry sequence — 256 main frames
5. A and B data — two 4-bit words
6. Parity — 12 bits
7. Frame sync — 28 bits (1111010111100101100110000000)
8. Format number (FN) — 4 bits
9. Status (ST) — A = 4 bits, B = 8 bits
10. Program instruction — 16 bits including 2 trailing ZEROs
11. Frame counter (FR CT) — 8 bits
12. Subcommutation channel (SC) — 8 bits

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Figure 1-7. SSS-A Telemetry Main Frame Format for the Accelerated Subcommutator Mode

Since there are 64 subcommutator words in subcommutators A and B, 64 main frames are required to obtain all the subcommutator information. This group of 64 main frames is called a subcommutator sequence. Tables 1-4 and 1-5 list the subcommutated words and identify the bit configuration. Since the subcommutator channels B8 through B11 denote the position of four power relays per channel, the method of determining their on or off position differs from the normal method. The method used to determine the status of the relays is as follows:

a. Strip out the eight telemetry bits.

b. Add a binary count of 3. The four most significant bits of the count now represent the values of A, B, C, and D, respectively (refer to Table 1-5). For subcommutator B8, a ONE equals the off condition and a ZERO equals the on condition. For subcommutators B9, B10, and B11, a ZERO equals the off condition and a ONE equals the on condition.

Example: If subcommutator B10 has an octal count of 316 (binary 11001110), add a count of 3 to the binary notation to get 11010001. Therefore, A = 1, B = 1, C = 0, D = 1, and indicates the channeltron, SSED, and SCADS power switches are on.

1.5.1.2 Secondary Telemetry Link

The high-power transmitter is the secondary telemetry link and operates on a frequency of 137.950 MHz with an output power of 3.0 watts. This is a wideband telemetry transmitter and is directly modulated by analog data from the ac electric and magnetic field detectors. This transmitter can also be commanded to an unmodulated carrier state. The baseband characteristics of the composite wideband analog signal are as follows:

Signal	Baseband Characteristics
S1	150 Hz to 10 kHz from the ac electric field sensor
S2	16.6-kHz reference carrier

Table 1-4. Telemetry Subcommutator A Word Identification

	DC Electric Fields		Solid-state Proton Detector
A1	Preamp temperature	A35	Heavy ion data 2
A2	Status	A36	Heavy ion data 3
A3	Antenna No. 1 output	A37	Heavy ion data 1
A4	Antenna No. 2 output	A38	Heavy ion data 4
A5	Differentiator X4 output	A39	Electronics temperature
A6	-15-volt monitor		AC Electric Fields
A7	+15-volt monitor	A40	Low voltage monitor
	Solid-state Electron Detector	A41	Spare
A8	Not used	A42	Long boom temperature
A9	Low-voltage test No. 2	A43	Command status
A10	Low-voltage test No. 3		SCADS
A11	High-voltage monitor	A44	Electronics temperature
A12	High-voltage at 30 kev detector	A46	Sensor temperature
A13	High-voltage at 50 kev detector	A47	High-voltage monitor
A14	Electronics temperature	A48	Low-voltage monitor
	Channeltron	A49	Threshold monitor
A15	High-voltage monitor	A50	Spare
A16	Low-voltage monitor		Transmitters and Command Receive
A17	A-detector continuity	A45	Experiment transmitter temperature
A18	B-detector continuity	A51	Data transmitter temperature
A19	C-detector continuity	A52	Receiver AGC
A20	D-detector continuity	A53	Spare
A21	E-detector continuity	A54	Data transmitter current monitor
A22	F-detector continuity		Instrumentation converter
A23	Positive E fixed level	A55	Instrumentation converter current monitor
A24	Positive F fixed level		Miscellaneous
A25	Electronics temperature	A57	MOSDAM
A56	Discriminator status	A58	Spare
	Magnetometers	A59	Spare
A26	-12-volt monitor	A60	Solid-state electron detector low-voltage test No. 1
A27	+5-volt monitor	A61	Spare
A28	-5-volt monitor	A62	Spare
A29	Auxiliary electronics temperature	A63	Spare
A30	Fluxgate temperature	A64	Spare
A31	X-Y search-coil temperature		
A32	Z search-coil temperature		
A33	Search-coil electronics temperature		
A34	Fluxgate shield temperature and separation indicator		

Table 1-5. Telemetry Subcommutator B Word Identification

Instrumentation Converter

B1 +12-volt bus
B2 Instrumentation converter temperature

Power Programmer

B3 Battery current
B4 Solar array current
B5 Payload current
B6 Battery voltage
B7 +28V bus voltage
B8* D/A PP No. 1 (analog functions)
- A — Bus on detector switch (K7)
- B — Experiment bus switch (K4)
- C — Discharge regulator switch (K2)
- D — Charge regulator switch (K1)

Command Programmer

B9* D/A PP No. 2 (analog functions)
- A — Mag power switch
- B — Solid-state proton detector power switch
- C — Experiment transmitter power switch
- D — Spare Experiment No. 1 power switch

B10* D/A PP No. 3 (analog functions)
- A — Channeltron power switch
- B — Solid-state electron detector power switch
- C — Spare
- D — SCADS power switch

B11* D/A PP No. 4 (analog functions)
- A — Optical aspect power switch
- B — Spare experiment No. 2 power switch
- C — AC electric field power switch
- D — DC electric field power switch

Solar Array

B12 Solar array top panel temperature
B13 Solar array middle panel temperature
B14 Solar array lower panel temperature

Structure

B15 Center tube top cone temperature
B16 Center tube temperature (battery)
B17 Battery temperature
B18 Spring seat temperature

Discharge Regulator

B19 Discharge regulator temperature

Data Processing System (Not at Connector)

B20 Buffer memory temperature
B21 Program memory temperature
B22 A/D converter temperature

B23 to B32 } Not used

Data Processing System

B33 Full scale calibration voltage
B34 Half scale calibration voltage
B35 System common calibration

B36 to B40 } Not used

Digital Performance Parameters

B41** Bits

8 - 6:	ASCS mode determination: -S(010) +S(011), -A(100), +A(101) A Direct (110) or ASCS OFF (111)
Bit 5:	Data sync clock Source: sun control (0) or mag field control(1)
Bit 4:	Not used
Bit 3:	Not used
Bit 2:	Not used

*Refer to paragraph 1.5.1.1 for method of determining status of power switches.
**Bit eight is the first bit transmitted.

Table 1-5. Telemetry Subcommutator B Word Identification (Cont)

B41 (Cont) Bit 1: Magnetometers: fluxgate range (1 = high, 0 = low)

B42 Not used.

B43** DPS: spacecraft clock sequence counter (most sign. half)

Bit	Bit Weight
1	1.740 days
2	3.480 days
3	6.959 days
4	13.919 days
5	27.838 days
6	55.676 days
7	111.351 days
8	222.702 days

B44** DPS: spacecraft clock sequence counter (least sign. half)

Bit	Bit Weight
1	9.787 minutes
2	19.573 minutes
3	39.147 minutes
4	1.305 hours

B44 (Cont)

Bit	Bit Weight
5	2.610 hours
6	5.220 hours
7	10.439 hours
8	20.878 hours

B45** Bit 8: Spare
Bit 7: Spare
Bit 6: Spare
Bit 5: Command programmer: pyrotechnics arm indicator, disarmed (0) or armed (1)
Bit 4: DPS: program mode (PI only) = 1, normal = 0)
Bit 3: DPS: clock select monitor: A = 0, B = 1
Bit 2: Magnetometer: search-coil range, high = 1, low - 0
Bit 1: Spare

B46 to B64 } Not used.

**Bit eight is the first bit transmitted.

Signal	Baseband Characteristics
S3	25-kHz subcarrier, amplitude modulated (suppressed subcarrier) by a 30-Hz to 300-Hz signal from the Z-axis search-coil magnetometer sensors
S4	33.3-kHz subcarrier, amplitude modulated (suppressed subcarrier) by a 30-Hz to 3-kHz signal from the X-Y-axis search-coil magnetometer sensor

The 3-watt transmitter is normally off and can be activated by ground command. The transmitter will operate simultaneously with the primary link. The amount that the direct modulated mode will be operated will be dependent upon the power availability in flight. It is anticipated that it will be operated on the average of about 10 percent of the orbits.

The 3-watt transmitter can be switched, using a tone-sequential command, from the analog data to a PCM/PM (backup) mode. The PCM data will be identical to that transmitted by the primary link. This mode is intended as a backup capability and does not interfere with the primary link.

1.5.2 TRACKING SUBSYSTEM

The primary 136.830-MHz telemetry link will provide the signal for the interferometer tracking subsystem; the 137.950-MHz secondary link can also be used if necessary.

1.5.3 COMMAND SUBSYSTEM

The 148.980-MHz command link will be used for loading programs into the on-board DPS, for experiment and attitude control, and for various other spacecraft functions that are required. The primary PCM command subsystem conforms to GSFC Aerospace Data Systems Standards.

A backup command subsystem using a tone sequence code is also provided. The modes of operation for both transmitters and the command subsystem modes are listed in Tables 1-6 and 1-7.

A total of 80 commands are used by the primary subsystem. These commands with their function are listed in Table 4-4. In the DPS programming mode (that is, load mode), the subsystem provides up to 256 instructions. The PCM command format is shown in Figure 1-8. The SSS-A will also utilize the standard GSFC tone-sequential subsystem to provide 18 backup commands in case the primary subsystem fails. These commands and their function are listed in Table 4-5.

Each of the 18 tone-sequential commands consists of a 4-tone sequence. Each tone burst and the space between tone bursts is 0.5 second in length. The first tone is the unique address tone for the spacecraft, and the last three tones are execute tones.

The characteristics of the spacecraft command receive subsystem are as follows:

a. Carrier frequency . . . . 148.980 MHz

b. Carrier modulation type . . . . AM

Table 1-6. SSS-A Telemetry Modes of Operation

Mode No.	Function	Transmit Frequency (MHz)	Modulation	Bit Rate (bps)	Modulation Factor (radians)	Assigned Bandwidth (kHz)	Power Output (watts)
1	Low-power transmitter, real-time PCM data (primary link)	136.830	PCM (split-phase)/PM	446	1.16	3	0.5
2	High-power transmitter, analog data (secondary link)	137.950	Composite/PM	analog	0.6	90	3.0
3	High-power transmitter, real-time PCM data (backup)	137.950	PCM (split-phase)/PM	446	1.16	3	3.0
4	High-power transmitter, CW	137.950	CW	NA	NA	3	3.0

Table 1-7. SSS-A Command Receiver/Decoder Mode of Operation

Mode No.	Receiver No.	Receiver Frequency	Code Type	Receiver Sensitivity
1	1	148.980 MHz	PCM/FSK-AM/AM	-116 dbm
2	1	148.980 MHz	Tone-sequential	-117 dbm

Message Sync		Address	Mode (Spare)	Mode	Usable Data Field	Parity Check Code	Sync
13 ZEROs	1	7 bits	1 bit	2 bits	29 bits	7 bits	4 ZEROs
0	13	14 20	21	23	24 52	53 59	60 63

a. Message Sync, bits 0—13 — Thirteen ZEROs followed by a ONE

b. Address, bits 14—20 — SSS-A address of 1000011

c. Mode, bits 21—23 — Bits 22 and 23 control spacecraft modes of operation. Bit 21 is a spare and always a ZERO. Bits 22 and 23 will be ZERO for spacecraft commands and ONE for load mode

d. Usable Data Field, bits 24—52 — Spacecraft commands or memory load bits are contained in this data field

e. Parity Check Code, bits 53—59 — These bits are used to check for bit errors in the command message

f. Sync, bits 60—63 — End-of-message sync is 4 ZEROs

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Figure 1-8. PCM Command Format

c. Prime command mode

(1) Modulation . . . . PCM/FSK — AM/AM

(2) FSK subcarriers

(a) ZERO bit . . . . 9,000 Hz

(b) ONE bit . . . . 9,640 Hz

(3) Command message length . . 64 bits

(4) Command bit rate . . . . . . 128 bps

(5) Command address 1000011

d. Backup command mode

(1) Modulation . . . . tone-sequential (PCM/AM/AM)

(2) Address code . . . . 1203 (5790 Hz)

(3) Execute code (3 tones per command) . . . . 1003 (2270 Hz)
1006 (3000 Hz)
1010 (3621 Hz)

e. Command receiver threshold

(1) PCM/FSK — AM/AM . . . . -116 dbm

(2) Tone-sequential (PCM/AM/AM) . . . . -117 dbm

1.5.4 ANTENNA SUBSYSTEM

The antenna subsystem consists of a diplexer, a hybrid, and a four element monopole array formed into a canted turnstile. The polarization of the antenna is right-hand circular along the forward spin axis, linear near the spacecraft equator, and left-hand circular along the shaft spin axis.

1.5.5 ATTITUDE DETERMINATION SUBSYSTEM

The optical aspect (OA) system will be the prime source of attitude data for operational usage. The OA consists of a solar sensor which measures the spin-axis sun angle in reference to the positive Z-axis of the spacecraft and an earth sensor which detects the crossing of the sunlit earth and provides a second reference for determining spacecraft spin axis orientation.

The scanning celestial attitude determination system (SCADS) is an engineering experiment to determine the spacecraft attitude to better than 0.1 degree. SCADS data will be acquired, by command, for about a 20-minute duration each orbit. Before operating the SCADS, a rough (few degrees) attitude must be determined using the OA system and predictions generated for acceptable periods of operation. This is necessary to prevent sightings of the sun or sunlit earth, or operations in zones of high radiation.

Operation of the SCADS is initiated by a single PCM command which causes the instrument to collect data at the threshold level previously set in the device. To determine the proper threshold level, 10 minutes of data will be collected, transmitted to the control center and analyzed by a software program of the ADO in near-real-time. Based on the findings, up to three PCM commands will be sent to fix the proper threshold and 10 minutes of attitude data will again be acquired. One PCM command will turn the SCADS off. Since the device employs latching relays, the threshold level will be retained after power is turned off. It will not be necessary to redetermine the level unless the spacecraft attitude is changed or the characteristics of the internal electronics change over a period of time.

1.5.6 STABILIZATION CONTROL SUBSYSTEM

The spacecraft attitude and spin control subsystem (ASCS) contains a magnetic torquing device to precess the spin axis and to trim the roll rate. An attitude coil in a plane perpendicular to the spin axis generates a magnetic moment parallel or anti-parallel to the spin axis. A spin coil, in a plane parallel to the spin axis, generates a pulsed moment perpendicular to the spin axis which, depending on polarity, causes torque along the spin axis. A total of five modes are possible, any one of which is selectable by ground command. The modes are as follows:

a. Attitude plus — Increases the right ascension of the spin axis about 6 to 7 degrees per perigee.

b. Attitude minus — Decreases the right ascension of the spin axis about 6 to 7 degrees per perigee.

c. Spin plus — Increases the spin rate about 0.1 rpm per perigee.

d. Spin minus — Decreases the spin rate about 0.1 rpm per perigee.

e. Attitude direct — Same as the attitude plus mode, except that the ASCS electronics are bypassed and power is applied directly to the attitude coil upon command.

The ASCS is enabled by one of five PCM commands. Typically a command will be given the ASCS on the inbound leg prior to the perigee for which a maneuver is required. When the spacecraft reaches a fixed field strength (approximately 7500 gammas), chosen to optimize the system, power is automatically applied to the appropriate coil. On the outbound leg, when the spacecraft again reaches the preset field strength, power is removed from the coil. A single PCM command turns the system off. If no off command is received, an on-board timer initialized at the time the system was enabled, will turn the ASCS off. This timer is set for about 5 to 7 hours depending on the ASCS electronics temperature.

The ASCS will be used to maintain the spin-axis sun-angle between 20 and 70 degrees as measured from the +Z axis (top of spacecraft); maintain the spin axis declination within ±10 degrees (referenced to the celestial equator); and maintain the final spin rate of 3.75 rpm ± 5%.

The spin rates of the spacecraft will be 125 rpm during the fourth stage burn, 10 rpm after yo-yo release, and 3.75 rpm after the boom deployment.

1.5.7 POWER SUPPLY SUBSYSTEM

The spacecraft power requirements are met by body mounted solar array panels having an initial average power output of 30 watts which is expected to degrade to 19 watts after a year in orbit. The battery is an 18 cell, 3 ampere-hour, silver cadmium device.

1.6 EXPERIMENTS

The SSS-A carries six scientific experiments which are described in the following paragraphs.

1.6.1 CHANNELTRON

The channel electron (channeltron) multipliers, in conjunction with cylindrical curved-plate electrostatic analyzers, will provide the basic particle detector system in the energy range from 500 ev to 25 kev. The analyzer resolving power is capable of achieving a 30-percent particle transmission at energy levels of 0.88 E_0 and 1.25 E_0, where E_0 is the energy most sensitive to the analyzer.

In addition to the above detectors, two detectors will be positioned to look parallel to the spin axis. They will obtain variations in intensity of the year, locally mirroring particles, because the spin axis will be oriented nearly perpendicular to the magnetic field lines. These detectors will measure electrons of about 2 and 20 kev with a fairly high time resolution. The principal investigators are R. A. Hoffman of GSFC and D. S. Evans of the National Oceanic and Atmospheric Administration (NOAA).

1.6.2 SOLID-STATE DETECTORS

The solid-stage electron detector will measure electron intensities in the energy ranges 35 to 70 kev, 70 to 140 kev, 140 to 250 kev, and 250 to 400 kev. Electrons will be selected by a 1000-gauss analyzing magnet and registered by a series of 300-micron-thick surface-barrier devices located within a magnetic shielding container. The principal investigator is D. J. Williams of NOAA.

The solid-state proton detector will measure proton intensities in twelve differential intervals from 20 kev to 1.12 Mev and at five integral energy levels; 20 kev, 130 kev, 300 kev, 2.08 Mev, and 2.35 Mev. Also, measurements of alpha particles and heavier ions will be made. The principal investigators are T. A. Fritz and D. J. Williams of NOAA, and A. Konradi of MSC.

1.6.3 MAGNETIC FIELD DETECTORS

The fluxgate magnetometer provides precise vector measurements of the static magnetic field from apogee down to at least 2 earth radii, geocentric, where the field magnitude varies from 100 to 400 gammas. In addition to the static measurements, low-frequency vector magnetic field fluctuations will be measured. A three-axis fluxgate magnetometer will be used as the detector. The range of each magnetometer is ±3000 gamma, and each output will be sampled about 30 times per second in the waveform mode with a 10-percent duty cycle, and continuously at twice per second. In-flight calibration and level check will be provided for this experiment.

The search-coil magnetometers will measure magnetic fluctuations from 1 to 3000 Hz with a db/dt sensor. Two sensors, perpendicular to each other will be mounted on 24-inch radial booms. Each sensor output will be transmitted to a set of seven bandpass filters which will be sampled about once each second. The principal investigator is L. Cahill of the University of Minnesota.

1.6.4 ELECTRIC FIELD DETECTORS

Electric field measurements will be made out to apogee. Both dc and ac components will be measured.

1.6.4.1 DC Electric Field Measurements

The dc component of the electric field is measured by monitoring the potentials of two spheres with respect to the spacecraft, and then subtracting these potentials differentially to remove the effects of the spacecraft. Geoelectric fields at apogee as small as approximately 0.1 volt/meter should be detected. The rotation of the spacecraft allows a two-component measurement to be made. In addition to the dc measurement, four spectrometer channels sample low-frequency variations between 0.3 and 30 Hz. The principal investigator is N. C. Maynard of GSFC.

1.6.4.2 AC Electric Field Measurements

The ac component of the electric field is measured by a series of narrow-band filters covering the frequency range of 20 Hz to 200 kHz. This range of frequencies includes the magnetospheric plasma frequencies at which electrostatic wave phenomena may be expected. The principal investigators are D. A. Gurnett and G. W. Pfeiffer of the University of Iowa.

SECTION 2

ORGANIZATION AND RESPONSIBILITIES

SECTION 2

ORGANIZATION AND RESPONSIBILITIES

2.1 INTRODUCTION

This section describes the organization and the responsibilities of the organizations supporting the SSS mission.

The Office of Space Science and Applications is responsible for the overall direction and evaluation of the SSS project.

2.2 PROJECT MANAGEMENT

The Goddard Space Flight Center (GSFC) is responsible for overall project management of the SSS Project. GSFC is responsible for the design, development, fabrication, and qualification acceptance tests of spacecraft hardware; for delivery of the spacecraft, subsystems, experiments, and ground support equipment; and for data utilization.

The Project Manager, Mr. Gerald W. Longanecker of the Explorer Project Office, represents the Director, GSFC, in all matters pertaining to the SSS Project. He is responsible for all phases of project planning direction, engineering, integration, evaluation and reporting. He is assisted by Mr. Frank A. Carr, Assistant Project Manager, and Mr. Kenneth O. Sizemore, Project Coordinator, in performing management functions; and by Dr. Robert A. Hoffman, Project Scientist, who is responsible for ensuring that the scientific objectives of the project are met.

The Project Operations Director (POD), Mr. Sterling Smith of the Explorer Project Office, is responsible to the Project Manager for the in-orbit operation of the spacecraft.

The Mission Operations Systems Manager (MOSM), Mr. William F. Mack of the Project Operations Branch, serves as the Project interface with the M&DO and Networks Directorates and is responsible for total ground systems support integrity.

2.3 LAUNCH VEHICLE AND LAUNCH SITE SUPPORT

The Langley Research Center (LaRC) is responsible for the Scout launch vehicle.

Mr. R. D. English, Head, Scout Project Office, is the Scout Launch Vehicle System Manager. He is responsible for launch vehicle system engineering and scheduling to meet project requirements. He is also responsible for the preparation of the necessary launch support documentation for a San Marco launch.

2.4 GROUND SYSTEMS SUPPORT

The Mission and Data Operations Directorate (M&DOD) is responsible for mission operations and orbit, attitude, and telemetry data reduction computation support. The Networks Directorate (ND) is responsible for Spaceflight Tracking and Data Network (STDN) station support and for ground communications between NASA supporting facilities.

2.4.1 MISSION SUPPORT MANAGER (MSM)

The MSM, Mr. William F. Mack of the Project Operations Branch, is the primary contact of the M&DOD with the Project. He is responsible for accepting Project requirements, levying requirements on support elements of M&DOD, assuring the commitment of adequate M&DOD resources, and implementing M&DOD support. He is the prime contact for the Network Support Manager concerning M&DOD/ND operational interfaces in support of the mission.

2.4.2 NETWORK SUPPORT MANAGER (NSM)

The NSM, Mr. Romo V. Cortez of the Operations Planning Section, is responsible for all ND support to the Project. He is responsible for accepting Project requirements and obtaining the commitment of ND resources. He is responsible for the committed resources, implementing Network Operations Support Plan, and readiness testing. He is the prime contact for the MSM concerning ND/M&DOD operational interfaces in support of the mission.

2.4.3 CONTROL CENTER OPERATIONS MANAGER

The Control Center Operations Manager (CCOM), Mr. Richard A. Schumacher of the Project Operations Branch, directs the operation of the Multi-Satellite Operations Control Center (MSOCC).

2.4.4 ORBITAL COMPUTATIONS ENGINEER

The Orbital Computations Engineer (OCE), Mr. William S. Soar of the Orbital Operations Branch, is responsible for all orbital computations activities.

2.4.5 ATTITUDE COMPUTATIONS ENGINEER

The Attitude Computations Engineer (ACE), Mr. Roger D. Werking of the Attitude Determination Office, is responsible for attitude computation activities.

2.4.6 DATA PROCESSING ENGINEER

The Data Processing Engineer (DPE), Mr. Clyde H. Freeman of the Telemetry Computation Branch, manages the Information Processing Division's (IPD) data processing and telemetry reduction mission support effort, and works with individual experimenters to determine the most useful form of individual outputs.

2.4.7 OPERATIONS ASSURANCE ENGINEER

The Operations Assurance Engineer (OAE), Mr. John R. Schneider of the Operations Assurance Section, is responsible for spacecraft and STDN compatibility testing and for establishing the necessary tests, exercises, and procedures to ensure an operational ground system.

2.4.8 COMMUNICATIONS ENGINEER

The Communications Engineer (CE), Mr. Terry Young of the Projects Communications Engineering Section, is responsible for coordination of premission requirements, planning, design, implementation, and testing of the NASCOM Network to ensure its operational readiness and its continuing operational compatibility with the overall mission requirements.

SECTION 3
GSFC OPERATIONS AND CONTROL

SECTION 3
GSFC OPERATIONS AND CONTROL

3.1 INTRODUCTION

The operation and control of the Goddard Space Flight Center (GSFC) ground support facilities utilized in support of the spacecraft mission are the responsibilities of the Mission and Data Operations Directorate (M&DOD) and the Networks Directorate (ND). The organization, facilities, and operational procedures used in discharging the Directorates' responsibilities are outlined in this section.

3.1.1 PROJECT OPERATIONS CONTROL CENTER

The Project Operations Control Center (POCC) for the SSS-A mission is the Multi-Satellite Operations Control which is located in Building 14 at GSFC. The POCC coordinates and monitors the spacecraft operations support and functions as the agency by which the Project controls the spacecraft during the lifetime of the spacecraft mission.

3.1.2 MISSIONS OPERATION CENTER

The Missions Operation Center (MOC) is the operational interface between the POCC and the Network Operations Control Center (NOCC). The MOC consists of the Mission Scheduling Operations Center (MISSOC) and the Operations Control Center (OPSCON).

3.1.2.1 Mission Scheduling Operations Center

The Mission Scheduling Operations Center (MISSOC), located in the annex to Building 14 at GSFC, coordinates and processes the mission support scheduling requirements received from the POCC's and resolves mission support conflicts. An integrated mission operations schedule is developed on a weekly basis and submitted to NOCC for scheduling STDN support.

3.1.2.2 Operations Control Center

The Operations Control Center (OPSCON), located in the annex to Building 14 at GSFC, monitors all POCC real-time operations for conformance with the requirements as submitted by MISSOC, performs real-time and near-real-time coordination of changes in mission support, and develops the operational summary reports from the resulting mission operations.

3.1.3 NETWORK OPERATIONS CONTROL CENTER

The Network Operations Control Center (NOCC), located in the annex to Building 14 at GSFC, provides operational control of the STDN in meeting spacecraft mission requirements. NOCC monitors the station status and determines availability of Network resources for scheduling the tracking, telemetry data acquisition, and command activities of the various STDN stations. These activities are scheduled in accordance with spacecraft priorities, station capabilities, and scheduling requests received from the Missions Operation Center and other users.

3.2 LAUNCH AND EARLY-ORBIT PHASE

The launch and early-orbit phase consists of prelaunch activities in preparation for launch and of activities up to the beginning of the normal phase. During the launch and early-orbit phase, the mission control function will be performed by the OPSCON Operations Director. The following personnel will be responsible to the Operations Director and will be present in OPSCON:

a. Assistant Operations Director

b. Mission Support Manager

c. Mission Operations Controller

d. Operations Assurance Engineer

The following personnel will not be present in OPSCON, but will be available as required:

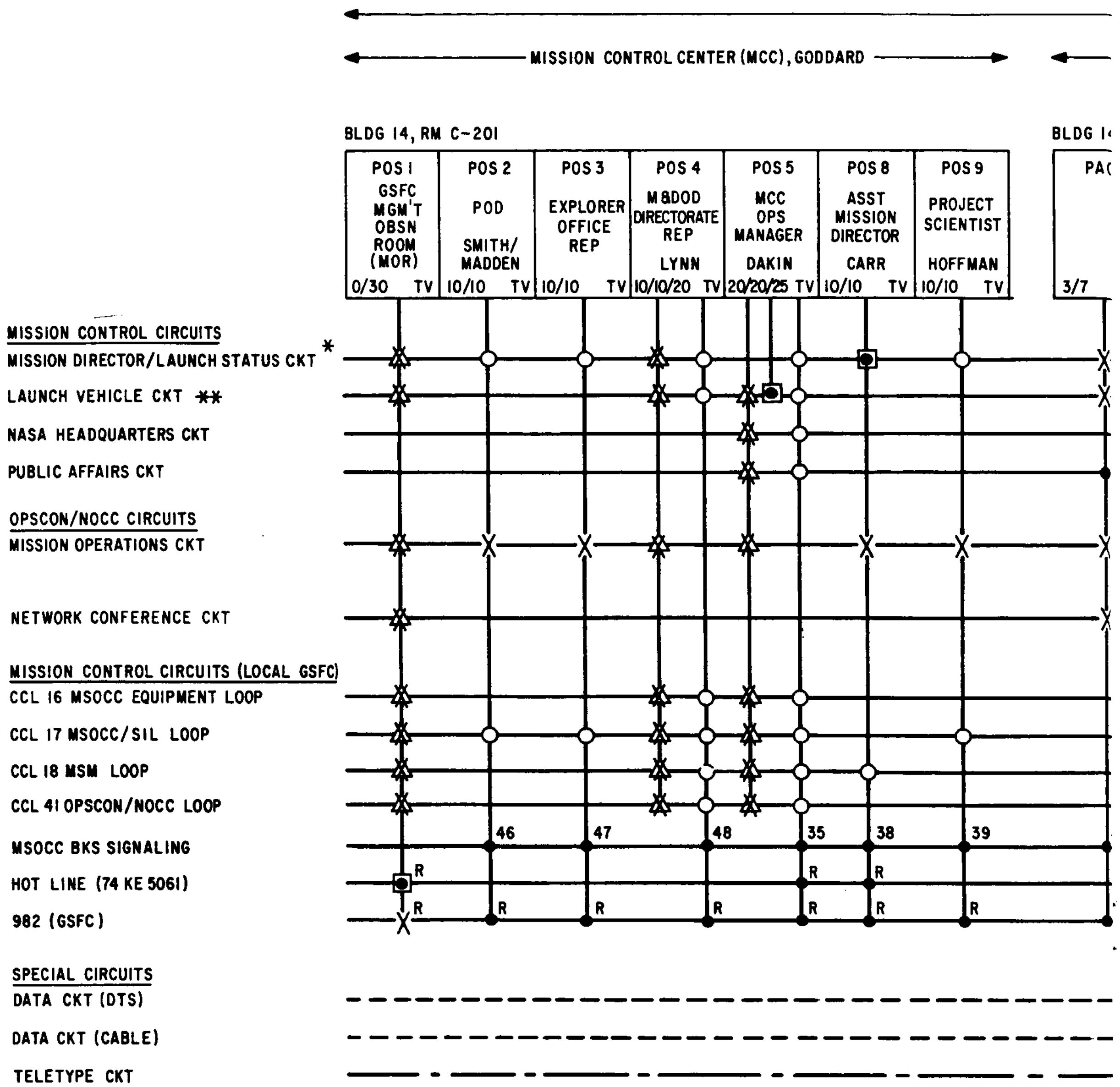
a. Orbital Computations Engineer

b. Communications Engineer

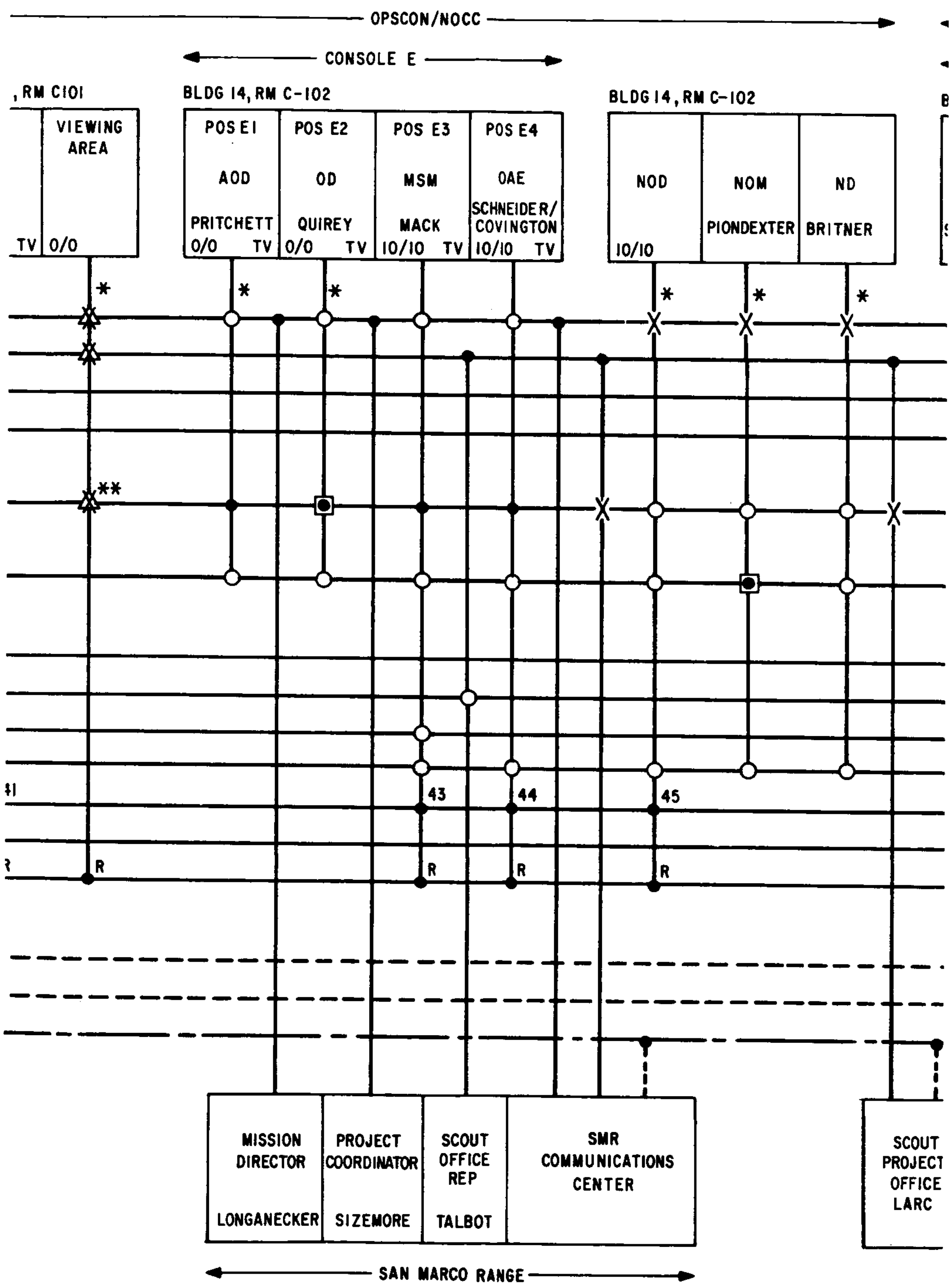
Additional personnel will be appointed as dictated by Project requirements.

3.2.1 TELEPHONE COMMUNICATIONS

Telephone communications will be established for the SSS-A mission to provide for effective control, liaison, coordination, and data collection. The composite communications network is illustrated in Figure 3-1.

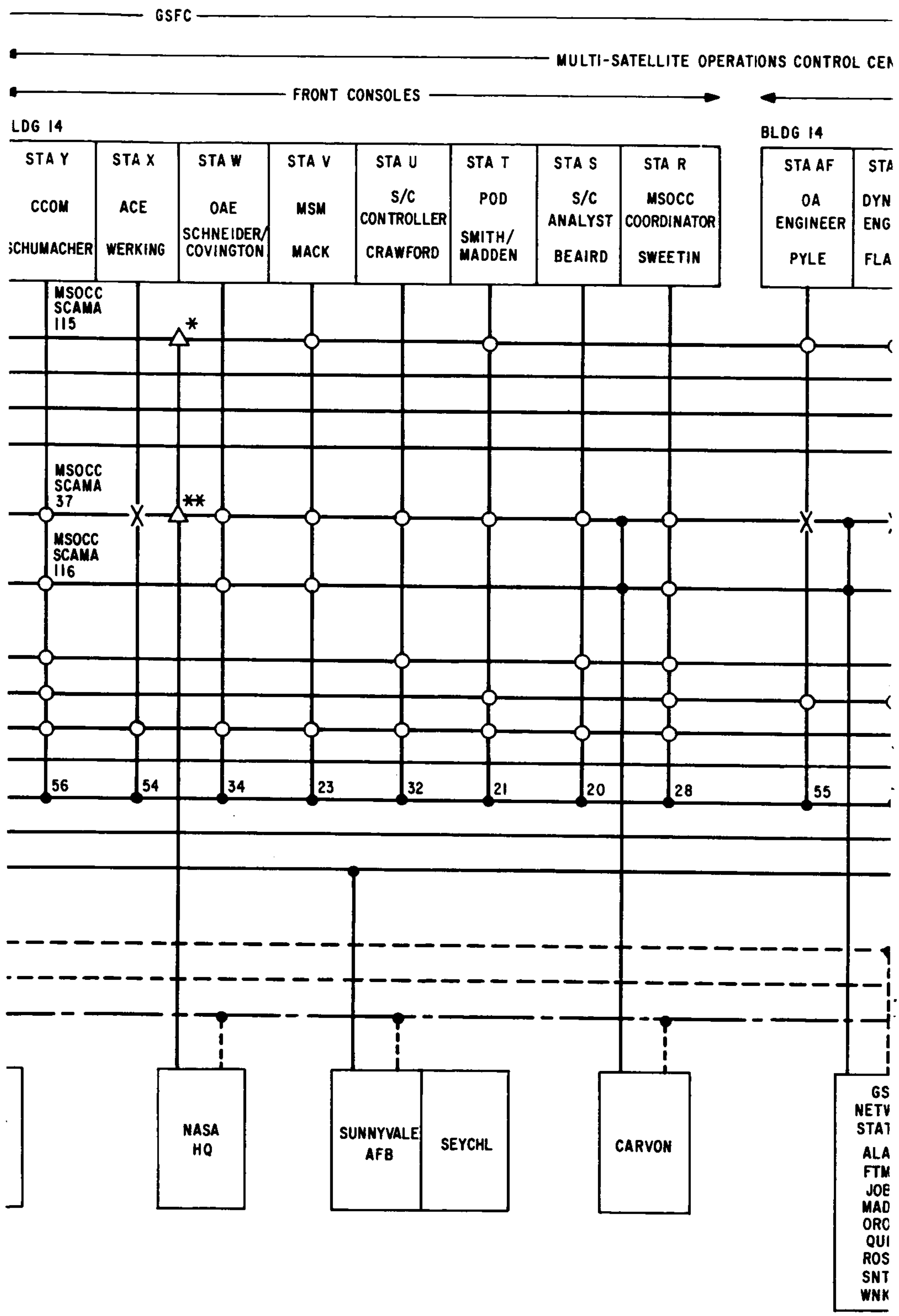


MISSION CONTROL CENTER (MCC), GODDARD
BLDG 14, RM C-201
BLDG 1
POS 1 GSFC MGM'T OBSN ROOM (MOR) 0/30 TV
POS 2 POD SMITH/ MADDEN 10/10 TV
POS 3 EXPLORER OFFICE REP 10/10 TV
POS 4 M&DOD DIRECTORATE REP LYNN 10/10/20 TV
POS 5 MCC OPS MANAGER DAKIN 20/20/25 TV
POS 8 ASST MISSION DIRECTOR CARR 10/10 TV
POS 9 PROJECT SCIENTIST HOFFMAN 10/10 TV
3/7
MISSION CONTROL CIRCUITS
MISSION DIRECTOR/LAUNCH STATUS CKT *
LAUNCH VEHICLE CKT **
NASA HEADQUARTERS CKT
PUBLIC AFFAIRS CKT
OPSCON/NOCC CIRCUITS
MISSION OPERATIONS CKT
NETWORK CONFERENCE CKT
MISSION CONTROL CIRCUITS (LOCAL GSFC)
CCL 16 MSOCC EQUIPMENT LOOP
CCL 17 MSOCC/SIL LOOP
CCL 18 MSM LOOP
CCL 41 OPSCON/NOCC LOOP
MSOCC BKS SIGNALING
HOT LINE (74 KE 5061)
982 (GSFC)
46
47
48
35
38
39
R
SPECIAL CIRCUITS
DATA CKT (DTS)
DATA CKT (CABLE)
TELETYPE CKT


OPSCON/NOCC
CONSOLE E
, RM C101
VIEWING AREA
TV 0/0
BLDG 14, RM C-102
POS E1
AOD
PRITCHETT
0/0 TV
POS E2
OD
QUIREY
0/0 TV
POS E3
MSM
MACK
10/10 TV
POS E4
OAE
SCHNEIDER/ COVINGTON
10/10 TV
BLDG 14, RM C-102
NOD
10/10
NOM
PIONDEXTER
ND
BRITNER
*
**
43
44
45
R
MISSION DIRECTOR
LONGANECKER
PROJECT COORDINATOR
SIZEMORE
SCOUT OFFICE REP
TALBOT
SMR COMMUNICATIONS CENTER
SCOUT PROJECT OFFICE LARC
SAN MARCO RANGE

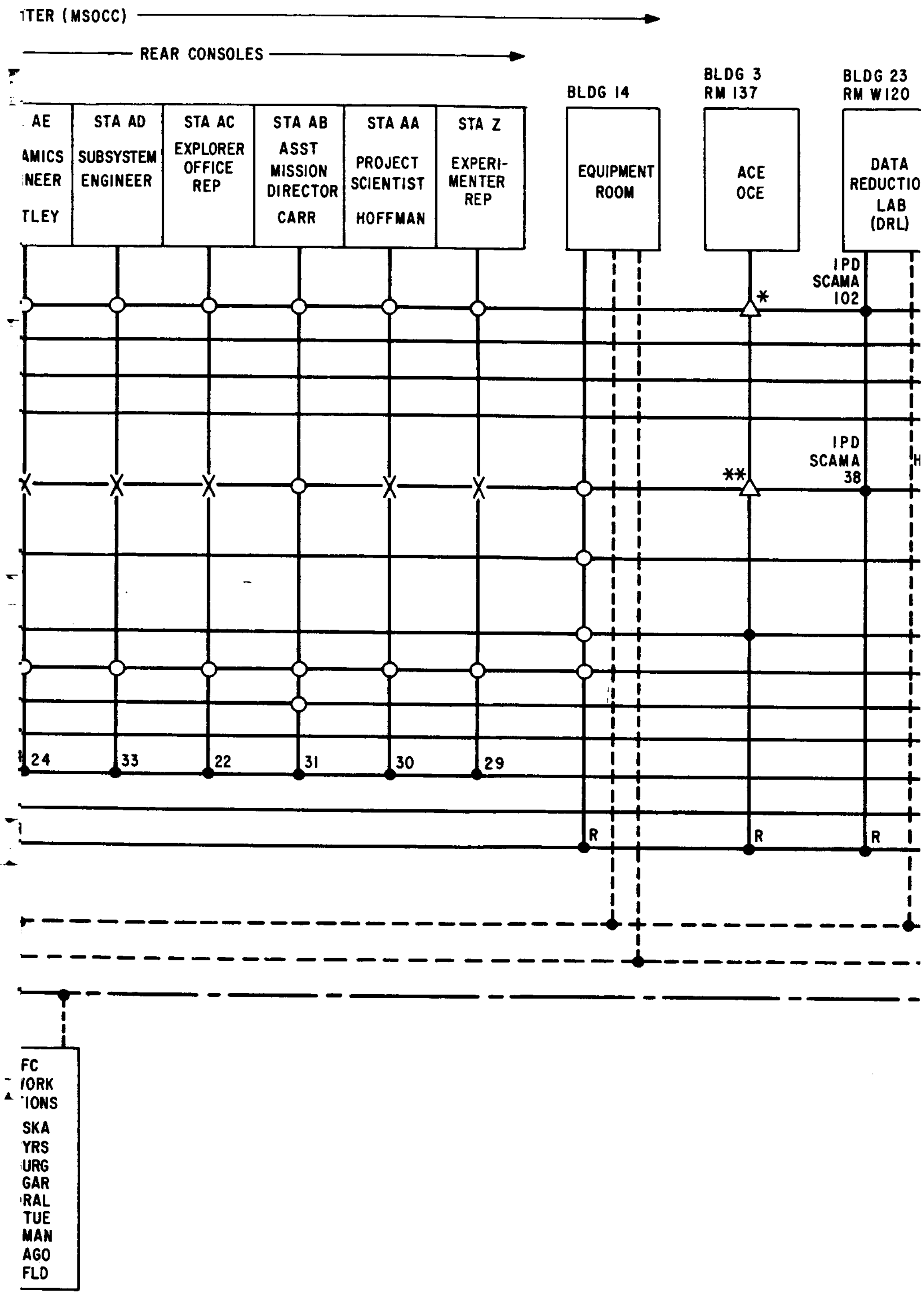
SSS-A

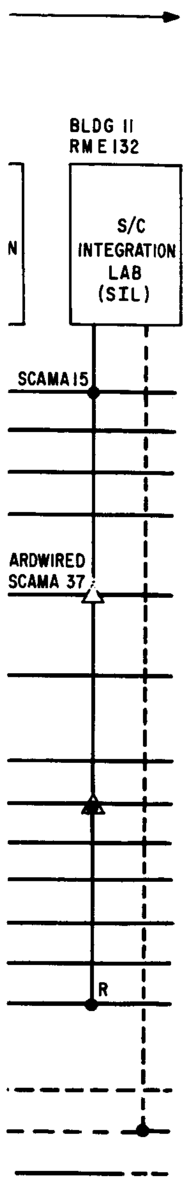
MUNICATIONS CHART WORKSHEET



MISSION ____________

DATE ____________





LEGEND

- VOICE CIRCUIT (HORIZONTAL LINE)
- DATA CIRCUIT (HORIZONTAL LINE)
- TELETYPE CIRCUIT (HORIZONTAL LINE)
- POSITION CIRCUIT PICKUPS (VERTICAL LINE)
- ● TALK/LISTEN CIRCUIT PICK-UP
- X MONITOR ONLY CIRCUIT PICK-UP
- O TALK/LISTEN PLUS MONITOR ONLY CIRCUIT PICK-UPS
- POSITION CONTROLLING T/L CIRCUIT PICK-UP
- △ POSITION WITH CIRCUIT ON MONITOR SPEAKER
- CIRCUIT ON MONITOR SPEAKER SELECTED FROM KEYSET
- R POSITION WHICH RINGS WHEN SIGNALED FROM REMOTE TERMINAL (AUDIBLE AND VISUAL SIGNALING)

* PATCHED FOR LAUNCH STATUS FROM T-30 TO T+15 MINUTES

** PATCH FOR MISSION OPERATIONS MONITOR AFTER T+15 MINUTES

935-9

Figure 3-1. Launch Communications

3.2.2 DISPLAYS

Prelaunch and real-time launch data pertaining to the mission will be displayed on illuminated screens located at the front of OPSCON. The Operations Center Branch is responsible for the implementation and operation of these displays. The following paragraphs describe the displays shown during the launch and early-orbit phase of the SSS-A mission. All of the displays may not be shown simultaneously, but will be projected as appropriate data are received.

3.2.2.1 Station Status

The current status of each participating Network station will be shown by a colored light at the geographic location of the station on the world map. The colors and their indications are as follows:

a. Amber — station not reported or status unknown

b. Red — station not ready

c. Green — station ready

d. Flashing green — acquisition of spacecraft signal

3.2.2.2 Launch Status

Items to be accomplished at the launch site during the terminal count will be displayed.

3.2.2.3 Launch Events and Orbital Elements

This display will present the nominal sequence of events during launch, the nominal orbital elements, and other pertinent information relating to the launch vehicle and spacecraft.

3.2.2.4 Subsatellite Plot

The nominal subsatellite plot to the end of orbit 1 will be displayed in OPSCON. The position of the spacecraft along this plot will be indicated in real-time.

3.2.2.5 Countdown Clock

The countdown clock will indicate in real-time the latest terminal count as received in OPSCON from the San Marco Range. Hold times also will be indicated.

3.2.2.6 GMT Clock

A clock indicating Greenwich Mean Time (GMT) is mounted directly above the countdown clock.

3.2.2.7 Terminal Countdown Display

A projection screen in the top center of the room will be used to view 35-mm slides. These slides will depict the terminal count and other launch activities.

3.2.2.8 Tracking and Telemetry Schedule

This schedule sequentially shows the stations which will acquire spacecraft tracking and telemetry data, and the predicted acquisition times.

3.2.3 MISSION CONTROL

During the launch and early-orbit phase, the Operations Center Branch is responsible for performing the following functions:

a. Preparing a composite mission schedule to ensure that maximum tracking data are obtained for computing the orbit at the earliest practicable time and that telemetry data are recorded in accordance with Project requirements and STDN capabilities.

b. Providing the Mission Support Manager (MSM) with periodic reports concerning STDN tracking, command, and telemetry activities. Unusual activities will be reported in near-real-time to the Multi-Satellite Operations Control Center (MSOCC).

c. Preparing a summary mission activity report no later than 0600 hours local time on each of the three consecutive days following launch for transmission to the MSOCC. This report will include such information as the number of minutes of telemetry recorded by the stations, any unusual occurrences, and the number and types of tracking messages.

d. Providing MSOCC with a copy of the initial telemetry/command schedule, pass changes if any, and updated or new schedules as they become available.

e. Ensuring the operation of appropriate displays.

f. Checking with the Orbital Operations Section and the Communications Operations Branch to ensure that the nominal predictions have been disseminated to all facilities participating in the SSS-A mission.

g. Confirming the nominal launch date and time to the NORAD/SDC, and SAO at T-10 days so that early-orbit tracking support will be prepared. Follow-up notices of launch date changes will be made as required.

h. Keeping the MSM and the MSOCC informed of the ability of the STDN stations to support the SSS-A mission when requested, beginning at T-1 day.

i. Notifying the GSFC switchboard at T-1 day of telephone service needed during launch.

j. Ensuring that the STDN stations are aware of their assigned responsibilities.

3.2.4 GROUND OPERATIONS CONTROL

The MSM and/or NSM are responsible for the following:

a. Maintaining liaison with the Project (MOSM) for the purpose of receiving and implementing changes in the Project requirements as needed.

b. Verifying that the Mission Operations Plan (OPPLAN), the Network Operations Support Plan (NOSP), station predictions, and orbital information have been distributed to those concerned and that all ground support elements are aware of their assigned responsibilities.

c. Ensuring that MSOCC is fully operational and capable of providing the necessary data to the SSS-A Project in accordance with the Project requirements.

d. Preparing the periodic operations and status reports concerning the SSS-A spacecraft and the ground support system.

e. Providing the Mission Scheduling Operations Control Center (MISSOC), by T-10 days, with the initial data acquisition and command requirements of the Project.

3.2.5 SPACECRAFT OPERATIONS CONTROL

The MSOCC will be responsible for the following:

a. Monitoring the SSS-A spacecraft operations.

b. Gathering pertinent launch information for the MSM.

c. Disseminating project-unique information.

d. Disseminating mission planning predictions (other than to STDN stations) as required.

e. Preparing listings, as requested by the MSM, of command and telemetry acquisition requirements, including real-time and near-real-time data transmission requirements for MSOCC data display and evaluation.

f. Maintaining records of any spacecraft anomalies, as reported in station pass summary messages or other sources.

g. Real-time spacecraft data processing and display.

3.3 NORMAL PHASE

The normal phase will begin when directed by the Operations Director. Unless unforeseen complications develop, this will occur as soon as the spacecraft status and orbit have been determined and updated orbital predictions have been computed and forwarded to the tracking and telelemetry stations.

3.3.1 MISSION CONTROL

During the normal phase, the Operations Center Branch is responsible for the following:

a. Scheduling and monitoring the mission operations in accordance with spacecraft priority listings, station capabilities, and Project requirements.

b. Providing MSOCC with STDN station status information throughout the active scientific lifetime of the spacecraft. Unusual events will not be restricted to a time frame but will be reported as dictated by the urgency of the situation and the need for a quick response.

c. Providing MSOCC with a copy of the final telemetry acquisition and command schedule, telemetry reports, pass summary messages, and changes thereto as they become available.

d. Scheduling voice/data and DTS circuitry between MSOCC and the participating stations, as required and requested by MSOCC.

3.3.2 GROUND OPERATIONS CONTROL

The MSM will be responsible for working closely with the Project Manager or his designated representative; for maintaining an up-to-date knowledge of the spacecraft status; for coordinating project requirements between the project and the M&DOD; for keeping the appropriate Directorate personnel informed of the Project status and ground support activities; and for coordinating and controlling all spacecraft and experiment operations. He will submit periodic spacecraft status and operations reports, as required.

3.3.3 MULTI-SATELLITE OPERATIONS CONTROL CENTER

The Multi-Satellite Operations Control Center (MSOCC) is located on the second floor of Building 14. MSOCC provides spacecraft control and real-time processing and display of spacecraft data. This control center is the interface between the Project and the support elements of the M&DOD during spacecraft operations.

Telemetry data from the stations will be transmitted to MSOCC via the data transmission system (DTS) and processed in the MSOCC by one of the XDS-930 computer systems. Wideband analog experiment data will be transmitted to MSOCC from ROSMAN via the microwave link. The MSOCC data transmission and processing flow is shown in Figure 3-2.

Real-time housekeeping data will be processed and displayed on-line. However, when real-time passes cannot be supported, selected data will be recorded on tape and then transmitted postpass to MSOCC via DTS at four times the normal bit rate of 446 bps (1784 bps).

Loading and verifying spacecraft program memory will normally be done by MSOCC via ROSMAN or QUITOE. Optical aspect (OA) and scanning celestial attitude determination system (SCADS) data will be stripped out of the telemetry data, formatted, and sent to the IBM 360/95 in real-time for use in attitude determination and control operations including SCADS threshold determination.

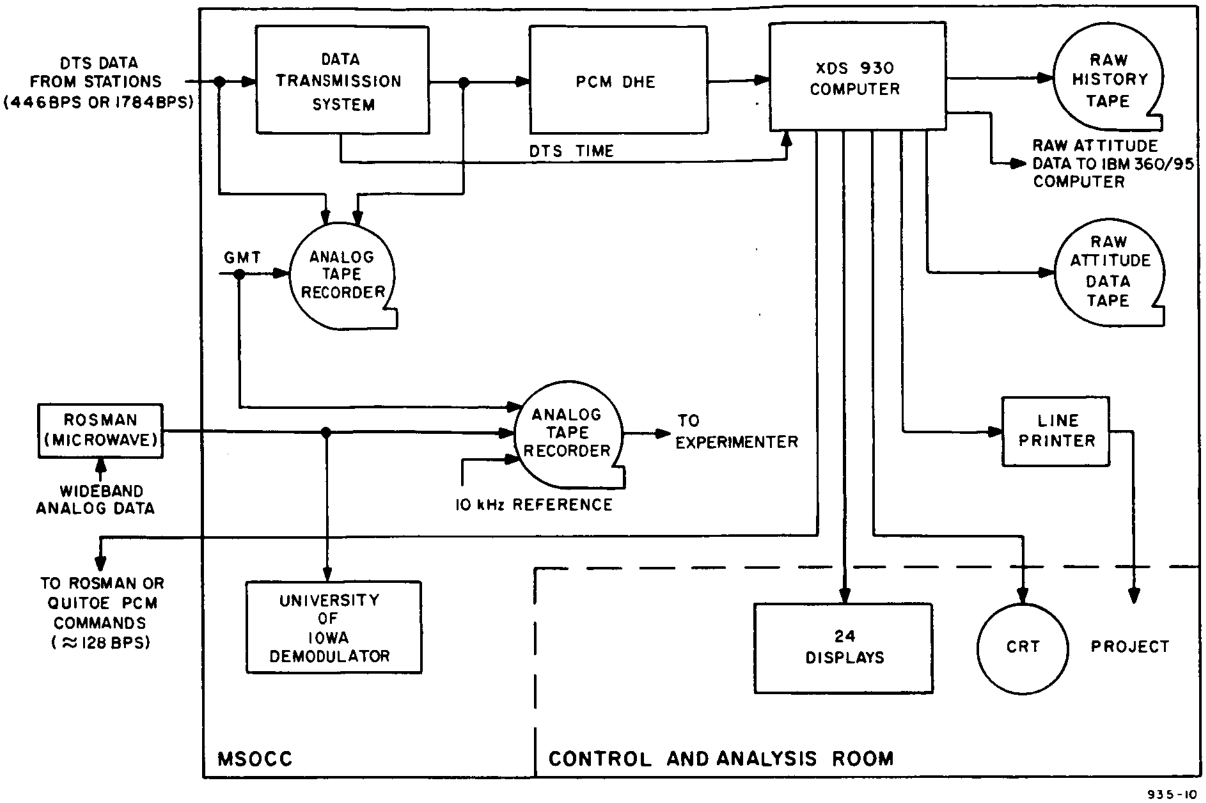


Figure 3-2. MSOCC Data Transmission and Processing Flow

3.3.4 ATTITUDE DETERMINATION AND CONTROL

The determination and control of spacecraft attitude will play an important role in accomplishing the objectives of the SSS-A mission. As a result, the Attitude Determination Office has developed an SSS attitude support software package to be operated on the IBM 360 computers. This package will be used to accomplish the objectives mentioned in the following sections. The major portion of the attitude data will be transferred from the MSOCC computer to the IBM S/360/95 via a data link. The SSS attitude support software package is expected to be operated on a daily basis with 24 hour response; however, the package is capable of operating in a real-time environment if data are available and the need exists.

3.3.4.1 Attitude Control

The attitude control requirements of SSS-A are dictated by scientific and spacecraft performance requirements. To satisfy the scientific objectives of the SSS-A mission, it will be necessary to keep the spin axis between ±10 degrees declination. The spacecraft thermal and power subsystems require that the angle between the spin axis and the sun line be maintained between 20 and 70 degrees. The spin rate is to be maintained at 3.75 rpm ± 5%. To meet these requirements, the SSS-A spacecraft is equipped with an optical aspect (OA) attitude determination subsystem and an attitude and spin control system (ASCS). The attitude support software package consists of an attitude determination program to process the OA data, an attitude prediction and control program, and an OA data prediction program. The OA attitude determination program to be used for SSS-A is a modified version of the program used on IMP-6. The program will use sun and horizon crossing data derived from the spacecraft and orbit data that was obtained from the orbit determination process to compute attitude and spin rate.

From the attitude which has been determined from the OA data, the attitude prediction and control program will be used to determine the attitude control commands necessary to satisfy mission objectives. The attitude prediction subprogram will consider the aerodynamic, magnetic and gravity gradient disturbance torques which will precess the spacecraft spin axis. These disturbance torques and the apparent motion of the sun will require the use of magnetic coils to precess the spin axis in a desired manner. The magnetic coils are designed to operate when the field sensed by a magnetometer perpendicular to the spin axis is greater than 75 milligauss. One coil used for attitude precession has the plane perpendicular to the spin axis while the coil used for spin rate control has the plane parallel to the spin axis. The attitude control subprogram will be used to decide the polarity and orbit on which the ASCS must be used to precess the spin axis to meet mission requirements.

The attitude prediction results will be used to determine the times during which the most useful OA data will be received from the spacecraft. These predictions will be made using an OA data availability program. This program will combine the attitude and orbit prediction results to determine the time during which the optical telescope will see the earth; this is one of the key requirements of the OA system on the spacecraft.

The following is a list of items which will be generated using the attitude support software in support of the SSS-A attitude control requirements.

a. Daily attitude results

b. Weekly attitude history

c. 30-day attitude prediction, updated weekly

d. Attitude control recommendations

e. OA data availability with recommended data transmission schedule.

3.3.4.2 Star Sensor Evaluation

The SSS attitude support software package includes programs necessary to evaluate the performance of the SSS-A star sensor. These programs consist of an attitude determination program and a star sensor gain selection program. The purpose of the SSS-A star sensor is to provide support for the SCADS engineering experiment, and insure that sufficient stars are available for definitive attitude processing. To accomplish these objectives, the Attitude Determination Office has developed the CDC Star Program. This program will use data obtained from the SCADS to determine attitude. The best way to evaluate and monitor the performance of the SCADS is to determine spacecraft attitude using SCADS data. The OA attitude results will be used as coarse attitude estimates for the initiation of the attitude determination process.

The star sensor gain selection program will be used to establish the gain setting which will provide a proper mix of stars to insure the success of the sensor for definitive data processing. They will likewise predict the times during which SCADS can be operated without the sensor seeing the sun or a sunlit earth. It is anticipated that the sensor will be capable of operation during spacecraft day.

The following items will be generated using the attitude support software.

a. SCADS gain settings.

b. SCADS operation's schedule.

c. Attitude results obtained from SCADS.

3.3.4.3 Definitive Attitude Determination

The SSS attitude support software package will be used to provide definitive spin axis attitude results. These results will be obtained from the OA data which was discussed earlier. However, the OA determination program will be rerun using definitive orbit data. The attitude results obtained from the OA data will be smoothed using the attitude prediction program. These smoothed attitude results will be combined with the definitive orbit data and delivered to the Information Processing Division. These data will be delivered on an orbit-attitude tape and will cover an interval of approximately four weeks.

3.4 MISSION SUPPORT CRITERIA

Mission support scheduling of tracking, telemetry, command, and data transmission operations will be conducted according to the criteria outlined in paragraphs 3.4.1 through 3.4.3.2.

3.4.1 TRACKING

Interferometer tracking of the spacecraft will be scheduled according to spacecraft priority and station capabilities for the maximum possible passes consistent with spacecraft transmitting power, that is, 0.5 or 3 watts.

It is anticipated that both spacecraft transmitters will be on at launch. Barring spacecraft problems, the 0.5-watt, 136.830-MHz transmitter will be on continuously for the operational life of the spacecraft. The 3-watt, 137.950-MHz transmitter may be left on continuously until at least the first shadow orbits. Eventually, it will be commanded on and off as requested by MSOCC to MISSOC. The 3-watt transmitter will be used for tracking whenever it is on; otherwise, the 0.5-watt transmitter will be used.

Because of the expected low elevation tracking angles at Winkfield, the tracking data from that station may prove to be unusable for spacecraft orbital computations. If so, the tracking support requirement for that station may be deleted after the first week of mission operations.

3.4.2 INITIAL SPACECRAFT OPERATIONS PHASE

Requests by MSOCC for telemetry, command, and data transmission support during the initial spacecraft operations phase will be provided to MISSOC at least 10 days prior to launch. This support will include the station activities described in Appendix C.

3.4.3 NORMAL SPACECRAFT OPERATIONS PHASE

The scheduling of telemetry, command, and data transmission support during the normal spacecraft operations phase will be based on the routine scheduling criteria to be followed by MISSOC and on special requests from MSOCC to MISSOC which MISSOC will integrate into the total mission support schedule request.

3.4.3.1 Routine Scheduling Criteria

The routine scheduling criteria for MISSOC will be as follows:

a. Data acquisition

(1) For all spacecraft orbits, MISSOC will schedule the mission support so that the maximum possible nonredundant PCM data can be recorded while the spacecraft is at altitudes above 6,400 kilometers. The Project objective for this mode of operation is to acquire at least 90 percent of the data while the spacecraft is at altitudes above 6,400 kilometers.

(2) On orbits requested by MSOCC, MISSOC will schedule mission support so that the maximum possible nonredundant wideband analog data can be recorded while the spacecraft is at altitudes above 6,400 kilometers. The expected average duty cycle for this mode of operation is 10 percent over the lifetime of the spacecraft; however, a greater duty cycle is anticipated early in the mission.

(3) MISSOC will request the use of either a SATAN or 85-foot antenna when the spacecraft is at altitudes above 6,400 kilometers to acquire wideband analog data. This requirement will not preclude acquiring PCM data when a SATAN or 85-foot antenna is not available. The 85-foot antenna is preferred, but is not mandatory for wideband analog data.

(4) Since PCM commanding is required every orbit, MISSOC will request the STDN stations having the SSS/IMP PCM command encoders as the prime stations for SSS-A data acquisition. The STDN stations that have the SSS/IMP command encoders are ROSMAN, QUITOE, JOBURG, and ORORAL.

(5) MISSOC will schedule the mission support for a minimum data recording time of 15 minutes (except when commanding) per station tape when the spacecraft is at altitudes above 6,400 kilometers. This applies for both PCM and wideband analog data.

(6) MISSOC will schedule a 5-minute station-to-station time overlap when appropriate.

b. Command

MISSOC will schedule the command transmission times for the following routine commands. These command transmission times will be included in the MSOCC pass assignment messages whenever a station is scheduled for additional commands during a pass.

(1) PCM command 055, fluxgate magnetometer sensitivity to high gain range. This command is sent every orbit when the spacecraft is at 23,000 ± 1,000 km ascending, but will not be scheduled unless the following command can also be scheduled.

(2) PCM command 055, fluxgate magnetometer sensitivity to low gain range. This command is sent every orbit when the spacecraft is at 23,000 ± 1,000 km descending.

c. Data transmission

MISSOC will request the following routine data transmission support.

(1) Real-time transmission twice per week of PCM data from an altitude of 6,400 km ascending to apogee or from apogee to an altitude of 6,400 km descending. These data are to be acquired and transmitted to IPD for recording in DRL during normal GSFC working hours on Monday and Thursday when possible.

(2) Real-time transmission once per week from ROSMAN to MSOCC via microwave of 30 minutes of wideband analog data acquired at altitudes above 6,400 km. These data will be recorded in MSOCC and the resultant tape will be shipped directly to the University of Iowa for quick-look processing.

3.4.3.2 Special Requests

The following special requests will be sent from MSOCC to MISSOC for mission support scheduling:

a. Data acquisition

(1) The acquisition of PCM data when the spacecraft is below an altitude of 6,400 kilometers if the data are required by the ADO for attitude sensor data content (i.e., OA data). This requirement may be necessary every orbit during some periods of operation.

(2) The acquisition of PCM data when the spacecraft is below an altitude of 6,400 kilometers if the data are required by the Project for engineering data during and/or after shadows. Typically, this requirement be necessary for only one orbit per week during shadow periods.

(3) The acquisition of wideband analog data when the spacecraft is above an altitude of 6,400 kilometers according to the duty cycle, or on those orbits specified by the Project.

b. Command

The transmission times for the following special commands will be included in the scheduling requests from MSOCC to MISSOC.

(1) Spacecraft experiment transmitter turn-on and turn-off as required.

(2) Changing the sensitivity of the fluxgate magnetometer every orbit.

(3) SCADS turn-on and turn-off every orbit. Typically, the SCADS will be operated for 20 minutes each orbit during the time periods specified by the Altitude Determination Office (ADO).

(4) Spacecraft spin up or spin down and spacecraft spin axis attitude corrections as specified by the Project (first 30 days) or by the ADO.

(5) Other spacecraft commands and program memory loads as specified by the Peoject.

c. Data transmission

Requests for scheduling the following special data transmissions will be sent from MSOCC to MISSOC.

(1) Real-time or postpass speeded up transmission of PCM data to MSOCC when required by the ADO for attitude data content. Typically, all OA data with earth sightings (one or two observations possible per orbit) will be transmitted to MSOCC plus one SCADS readout per day.

(2) Real-time transmission of PCM data to MSOCC when needed for quick-look processing support of such activities as spacecraft spin axis attitude corrections, program memory loading, routine checkouts, and so forth.

3.4.3.3 Special Reports

In addition to the standard reports, the following special reports are required:

a. MISSOC will report to the MSM whenever 90 percent or more of the PCM data above 6,400 kilometers is not obtained during any one week scheduling period.

b. MISSOC will provide MSOCC with consolidated listings of all spacecraft commands tabulated from station PASSUMS.

c. MSOCC will complete the above command listings (including commands transmitted to the STDN stations from MSOCC) using all available sources of information for validation of command verifications and provide final lists to the Project on a monthly basis.

SECTION 4

STDN OPERATIONS

SECTION 4
STDN OPERATIONS

4.1 INTRODUCTION

This section defines the responsibilities of the STDN stations supporting the SSS-A mission and outlines the operational procedures used to fulfill mission requirements during the normal spacecraft operations phase. Station support during the initial spacecraft operations phase is defined in Appendix A.

The stations involved in supporting this mission and an outline of their responsibilities are contained in Table 4-1. Tracking, command, telemetry data acquisition, and data transmission support at these stations will be scheduled by the Network Operations Control Center (NOCC).

4.2 TRACKING

The STDN stations, listed in Table 4-1, will interferometer track the primary telemetry link (136.830 MHz), or, if required, the secondary telemetry link at 137.950 MHz. Tracking passes will be scheduled to provide sufficient tracking data to maintain the specified accuracy of orbital data. Tracking data will be transmitted to COMPUT (GPUT and GWWW) via TTY according to existing standard operating procedures.

4.3 COMMAND

The STDN stations, listed in Table 4-1, will be scheduled to provide command support for the SSS-A mission. QUITOE, JOBURG, ORORAL, and ROSMAN are equipped with the special purpose SSS/IMP command encoder. Command operations must be performed by a station equipped with both a PCM command system and a DTS link to GSFC for real-time data analysis. These four stations will normally be the only ones responsible for commanding the spacecraft.

The SSS/IMP command encoder will be used as the primary command system. The encoder will be used to load the on-board data programs and to provide the individual command functions listed in paragraph 4.7.7. Command operations will be required as follows:

a. Experiment activation required through the first few days.

b. Attitude control maneuvers are estimated to be required on an average of once per week.

Table 4-1. Participating Network Stations

Station Location	Station Code	TTY Code	Responsibility			
			Tracking	Data Recording	Data Transmission	Command
Fairbanks, Alaska	ALASKA	GULA		X	X	2
Fort Myers, Florida	FTMYRS	GYRS	X	X	X	2
Johannesburg, South Africa	JOBURG	GBUR	X	X	X	1,2
Tananarive, Madagascar	MADGAR	LTAN	X	X	X	2
Canberra, Australia	ORORAL	AORR	X	X	X	1,2
Quito, Ecuador	QUITOE	GQUI	X	X	X	1,2
Rosman, North Carolina	ROSMAN	GROS		X	X	1,2
Santiago, Chile	SNTAGO	GAGO	X	X	X	2
Seychelles,* Mahe Island	SEYCHL	GSRM		X		
Winkfield, England	WNKFLD	LWNK	X	X	X	2
Carnarvon,* Australia	CARVON	ACRO		X		

*Launch support only
1- PCM
2- Tone-sequential

c. Spin control operations are estimated to be required twice per week.

d. SCADS command operations are required once per orbit.

e. Wideband data commanding is required on an average of once per ten orbits.

f. Program memory loading will be required an average of twice a month.

g. Experiment detector reconfiguration will be performed as required.

h. Spacecraft reconfiguration and corrective actions will be performed as required.

The backup command system of SSS-A is a tone-sequential system and has the capability of 18 commands for selected spacecraft functions. The backup system will be used only if the normal PCM command mode fails, and to control the data mode of the wideband transmitter.

4.4 DATA ACQUISITION

The STDN stations, listed in Table 4-1, will be scheduled to acquire and record PCM and analog telemetry data for the mission lifetime. Telemetry formats are explained in Section 1.

4.4.1 DATA RECORDING

Each station will record data on an FR-600, or equivalent, tape recorder. When both PCM and analog data are acquired on a scheduled pass, two recorders will be used: one for PCM data and one for analog data. When the 137.950-MHz secondary link is used in the backup mode for PCM data, only one recorder (Figure 4-1) will be used. Recorder track assignments are specified in paragraph 4.6.3.

4.4.2 TAPE MAILING

Recorded tapes will be packaged for shipment according to standard procedures and mailed to the following address:

NASA Goddard Space Flight Center
Building 16
Greenbelt Road
Greenbelt, Maryland 20771, U.S.A.

M/F Data Processing Branch, Code 564 Analog Tape Library

4.5 DATA TRANSMISSION

Selected 446-bps real-time telemetry data will be transmitted from the supporting stations to GSFC, via the data transmission system (DTS) or microwave. ROSMAN will transmit selected PCM and wideband analog data to GSFC via an existing microwave link. The stations may be required to play back portions of the recorded PCM data at four times the recorded speed via the DTS to GSFC.

4.6 EQUIPMENT CONFIGURATION

The station equipment configuration for primary or secondary spacecraft telemetry support is shown in Figure 4-1. The telemetry configuration for SEYCHL is shown in Figure 4-2. The telemetry configuration for CARVON is shown in Figure 4-3. Equipment controls not specified in the following paragraphs should be set as specified in the applicable Operating Control Directives (OCD) and technical manuals.

4.6.1 TRACKING

The interferometer system will be configured according to existing standard operating procedures, with a center frequency of 136.830 MHz and an AGC speed of 10 Hz for the primary link, or 137.950 MHz with an AGC speed of 10 Hz for the secondary link.

4.6.2 TELEMETRY

4.6.2.1 Antenna

a. Frequency . . . . 136-MHz band

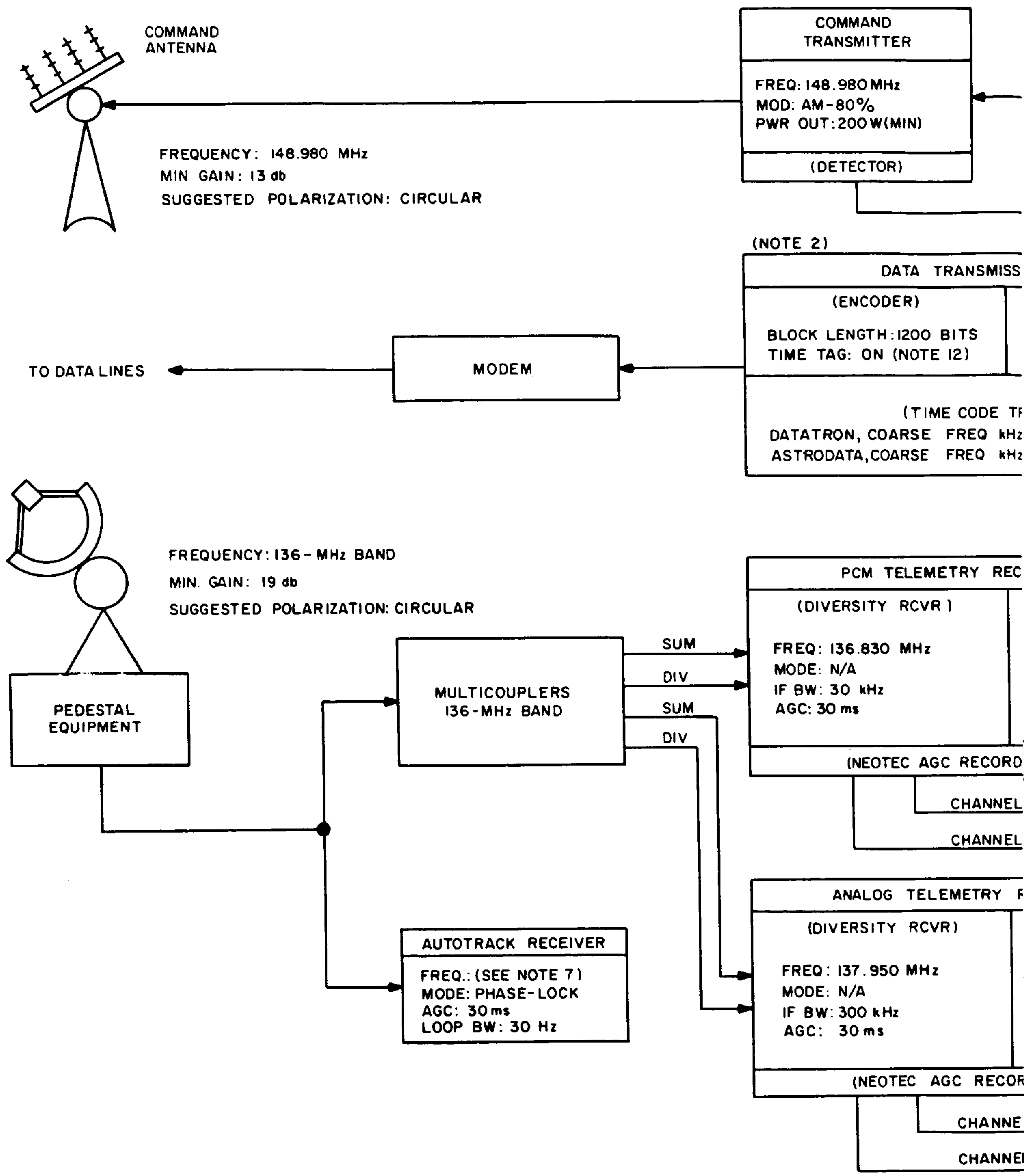
b. Polarization (suggested) . . . . . circular

c. Gain (minimum) . . . . +19 db

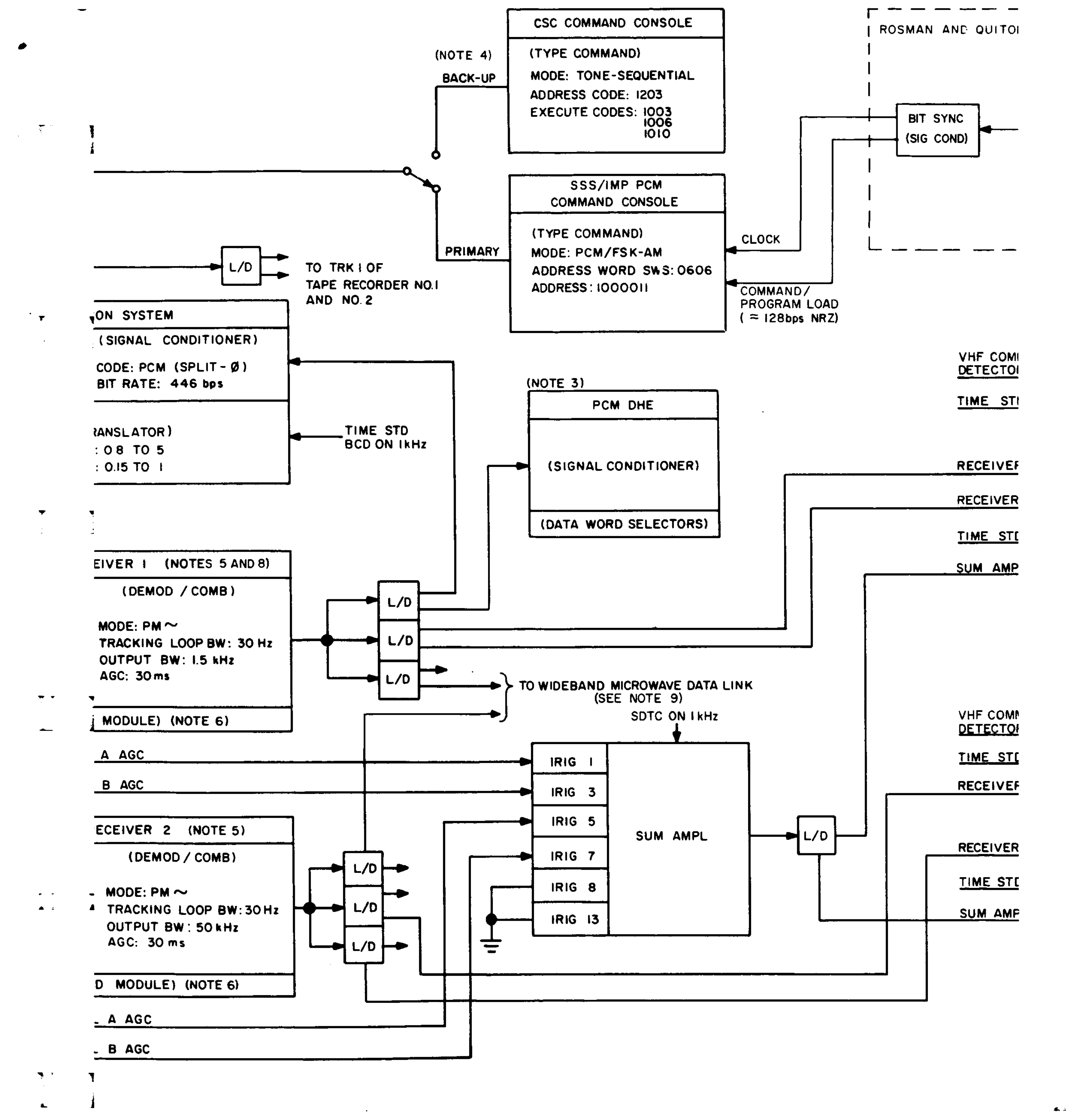
4.6.2.2 Autotrack Receiver

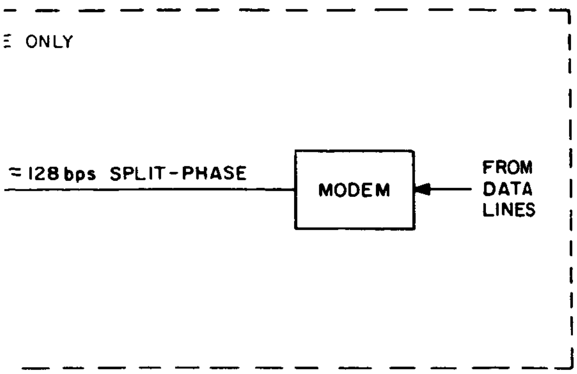
a. Center frequency

(1) Low-power transmitter . . . 136.830 MHz (primary)



COMMAND ANTENNA
FREQUENCY: 148.980 MHz
MIN GAIN: 13 db
SUGGESTED POLARIZATION: CIRCULAR
COMMAND TRANSMITTER
FREQ: 148.980 MHz
MOD: AM-80%
PWR OUT: 200 W(MIN)
(DETECTOR)
(NOTE 2)
DATA TRANSMISS
(ENCODER)
BLOCK LENGTH: 1200 BITS
TIME TAG: ON (NOTE 12)
TO DATA LINES
MODEM
(TIME CODE TI
DATATRON, COARSE FREQ kHz
ASTRODATA, COARSE FREQ kHz
FREQUENCY: 136-MHz BAND
MIN. GAIN: 19 db
SUGGESTED POLARIZATION: CIRCULAR
PCM TELEMETRY REC
(DIVERSITY RCVR)
FREQ: 136.830 MHz
MODE: N/A
IF BW: 30 kHz
AGC: 30 ms
SUM
DIV
SUM
DIV
MULTICOUPLERS
136-MHz BAND
PEDESTAL EQUIPMENT
(NEOTEC AGC RECORD
CHANNEL
CHANNEL
ANALOG TELEMETRY F
(DIVERSITY RCVR)
FREQ: 137.950 MHz
MODE: N/A
IF BW: 300 kHz
AGC: 30 ms
AUTOTRACK RECEIVER
FREQ.: (SEE NOTE 7)
MODE: PHASE-LOCK
AGC: 30 ms
LOOP BW: 30 Hz
(NEOTEC AGC RECOR
CHANNE
CHANNEI


CSC COMMAND CONSOLE
(TYPE COMMAND)
MODE: TONE-SEQUENTIAL
ADDRESS CODE: 1203
EXECUTE CODES: 1003 1006 1010
(NOTE 4)
BACK-UP
PRIMARY
SSS/IMP PCM COMMAND CONSOLE
(TYPE COMMAND)
MODE: PCM/FSK-AM
ADDRESS WORD SWS: 0606
ADDRESS: 1000011
CLOCK
COMMAND/ PROGRAM LOAD (≈ 128bps NRZ)
ROSMAN AND QUITO
BIT SYNC (SIG COND)
L/D
TO TRK I OF TAPE RECORDER NO.1 AND NO.2
ON SYSTEM
(SIGNAL CONDITIONER)
CODE: PCM (SPLIT-Ø)
BIT RATE: 446 bps
RANSLATOR)
: 0.8 TO 5
: 0.15 TO 1
TIME STD BCD ON 1kHz
(NOTE 3)
PCM DHE
(SIGNAL CONDITIONER)
(DATA WORD SELECTORS)
VHF COM
DETECTO
TIME ST
RECEIVER
RECEIVER
TIME ST
SUM AMP
EIVER 1 (NOTES 5 AND 8)
(DEMOD / COMB)
MODE: PM ~
TRACKING LOOP BW: 30 Hz
OUTPUT BW: 1.5 kHz
AGC: 30 ms
MODULE) (NOTE 6)
TO WIDEBAND MICROWAVE DATA LINK (SEE NOTE 9)
SDTC ON 1 kHz
A AGC
B AGC
IRIG 1
IRIG 3
IRIG 5
IRIG 7
IRIG 8
IRIG 13
SUM AMPL
ECEIVER 2 (NOTE 5)
(DEMOD / COMB)
MODE: PM ~
TRACKING LOOP BW: 30 Hz
OUTPUT BW: 50 kHz
AGC: 30 ms
D MODULE) (NOTE 6)
A AGC
B AGC
VHF COM
DETECTO
TIME ST
RECEIVER
RECEIVER
TIME ST
SUM AMP



(NOTE 8)

FR-600 TAPE RECORDER NO. 1 SPEED: 3-3/4 IPS		
TRK	RECORD AMPL	SIGNAL
1	DIRECT	COMMANDS
2	DIRECT	10-kHz REF
3	DIRECT	BLANK
4	DIRECT	PCM DATA
5	FM	PCM DATA
6	DIRECT	BCD TIME ON 1 kHz
7	DIRECT	MULTIPLEXED AGCs AND SDTC ON 1 kHz

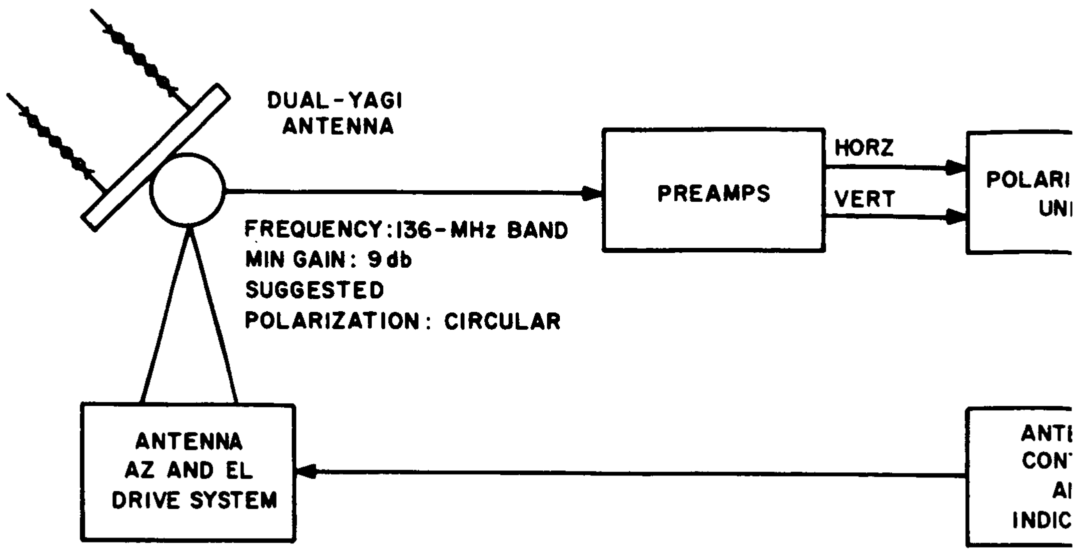
FR-600 TAPE RECORDER NO. 2 SPEED: 15 IPS		
TRK	RECORD AMPL	SIGNAL
1	DIRECT	COMMANDS
2	DIRECT	10-kHz REF
3	FM	ANALOG DATA
4	DIRECT	BLANK
5	DIRECT	ANALOG DATA
6	DIRECT	BCD TIME ON 1 kHz
7	DIRECT	MULTIPLEXED AGCs AND SDTC ON 1 kHz

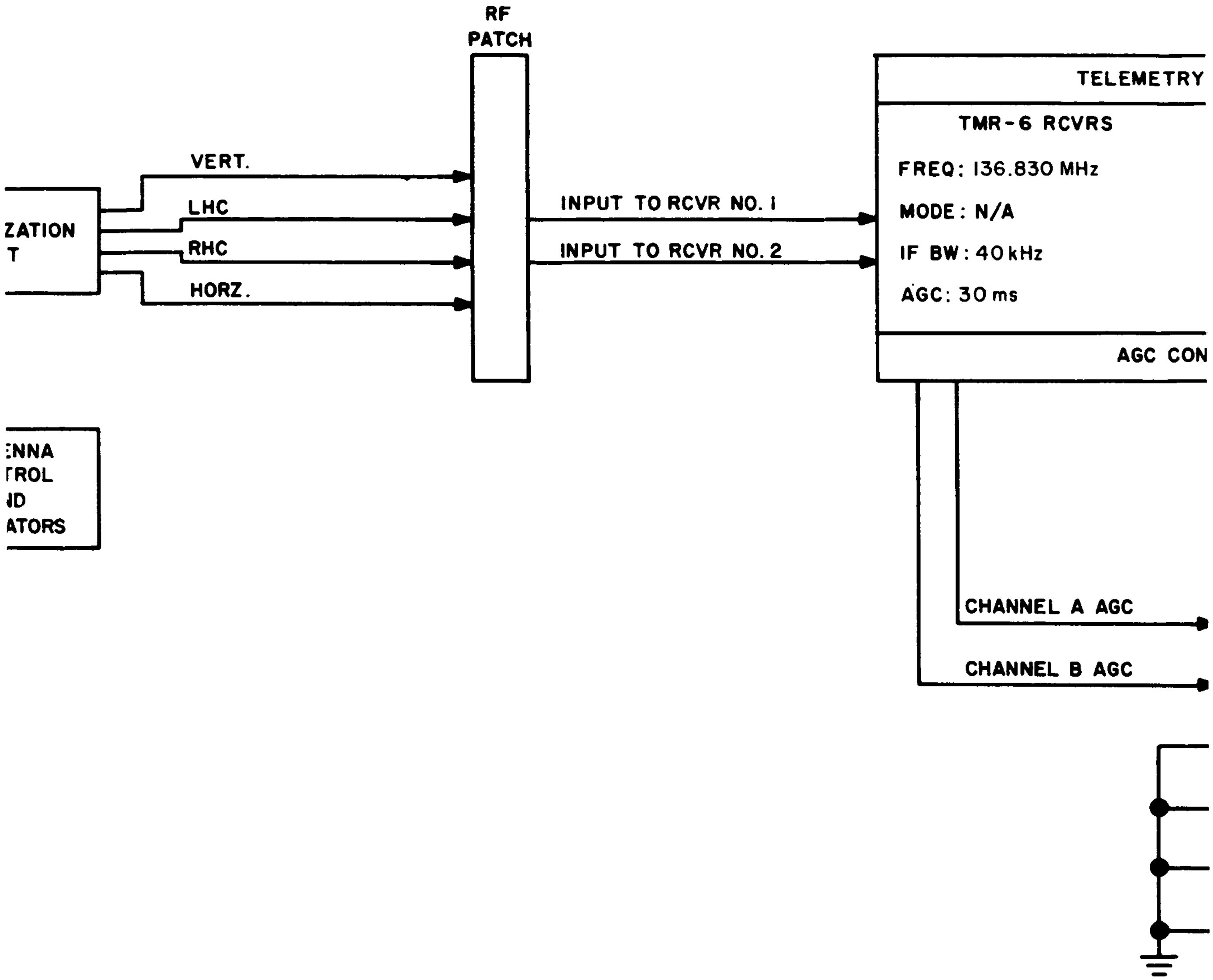
NOTES:

1. L/D DENOTES LINE DRIVER.
2. REAL-TIME DATA (446 bps) WILL BE TRANSMITTED TO GSFC OVER DTS DURING THE PASS USING A 1200 BIT BLOCK LENGTH.
3. FOR QUICK-LOOK.
4. FOR BACKUP COMMAND CAPABILITY, 18 TONE-SEQUENTIAL COMMANDS ARE AVAILABLE CONSISTING OF AN ADDRESS TONE FOLLOWED BY THREE EXECUTE TONES.
5. DTR SETTINGS; REFER TO TEXT FOR OTHER RECEIVER SETTINGS.
6. NEOTEC AGC RECORD MODULE NOT USED WITH MFRT.
7. PRIMARY FREQUENCY FOR AUTOTRACK IS 136.830 MHz; SECONDARY FREQUENCY IS 137.950 MHz.
8. WHEN THE SECONDARY LINK (137.950 MHz) IS USED FOR PCM DATA, USE RECEIVER I AND RECORDER I CONFIGURATION WITH RECEIVER AT 137.950 MHz.
9. AT ROSMAN, MICROWAVE IS REQUIRED FOR WIDEBAND ANALOG DATA AND IS BACKUP FOR PCM DATA. HOWEVER, DTS FOR PCM PREFERRED. AT ALASKA, MICROWAVE IS BACKUP FOR PCM DATA AND IS NOT REQUIRED FOR WIDEBAND ANALOG DATA.
10. ORORAL 202 DATA MODEM AND BIT SYNC REQUIRED FOR REDUNDANT PCM DATA DURING THE LAUNCH PHASE ONLY.
11. OVERLAP OF RECORDING REQUIREMENTS FOR MULTI-TAPE RECORDINGS IS 5 MINUTES FOR PCM DATA AND 1 MINUTE FOR WIDEBAND ANALOG DATA.
12. FOR ALASKA ONLY, POSITION TIME TAG TO OFF.

935-11

Figure 4-1. Telemetry and Command Equipment Configuration for SSS-A Mission


DUAL-YAGI
ANTENNA
PREAMPS
HORZ
VERT
POLARI
UNI
FREQUENCY:136-MHz BAND
MIN GAIN: 9db
SUGGESTED
POLARIZATION: CIRCULAR
ANTENNA
AZ AND EL
DRIVE SYSTEM
ANTI
CON
AI
INDIC


RF
PATCH
TELEMETRY
TMR-6 RCVRS
FREQ: 136.830 MHz
MODE: N/A
IF BW: 40 kHz
AGC: 30 ms
AGC CON
VERT.
LHC
RHC
HORZ.
ZATION
T
INPUT TO RCVR NO. 1
INPUT TO RCVR NO. 2
ENNA
TROL
ND
ATORS
CHANNEL A AGC
CHANNEL B AGC

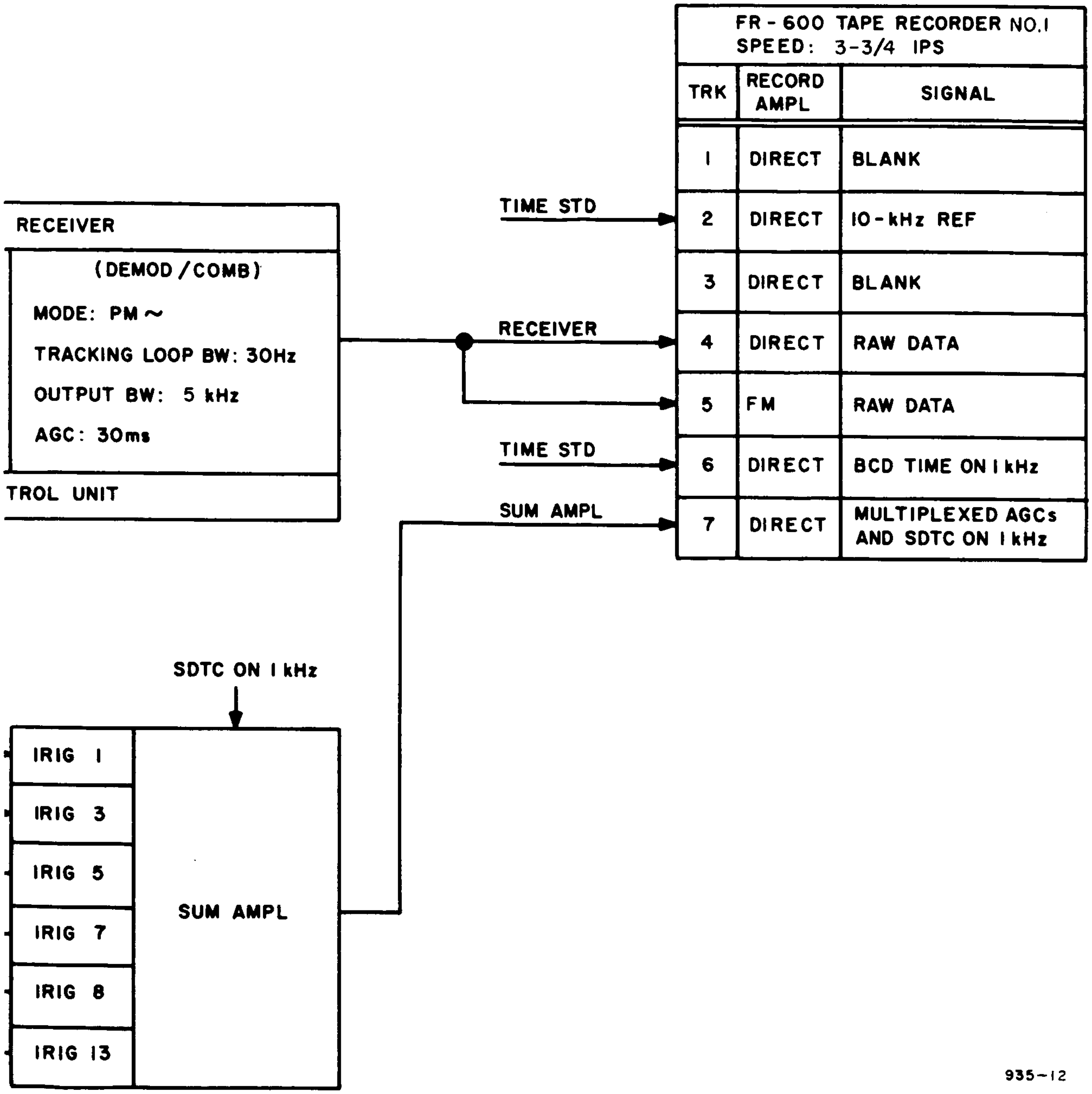
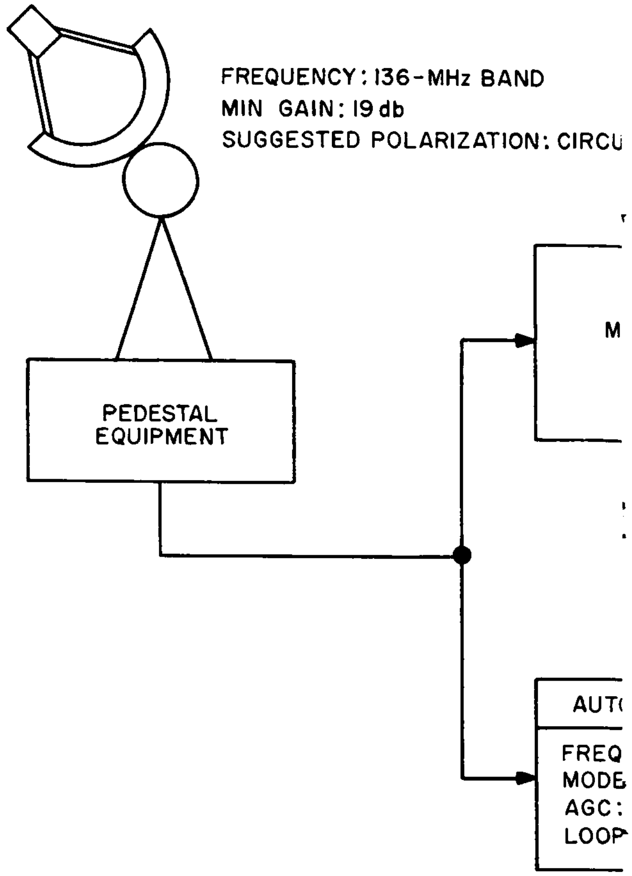
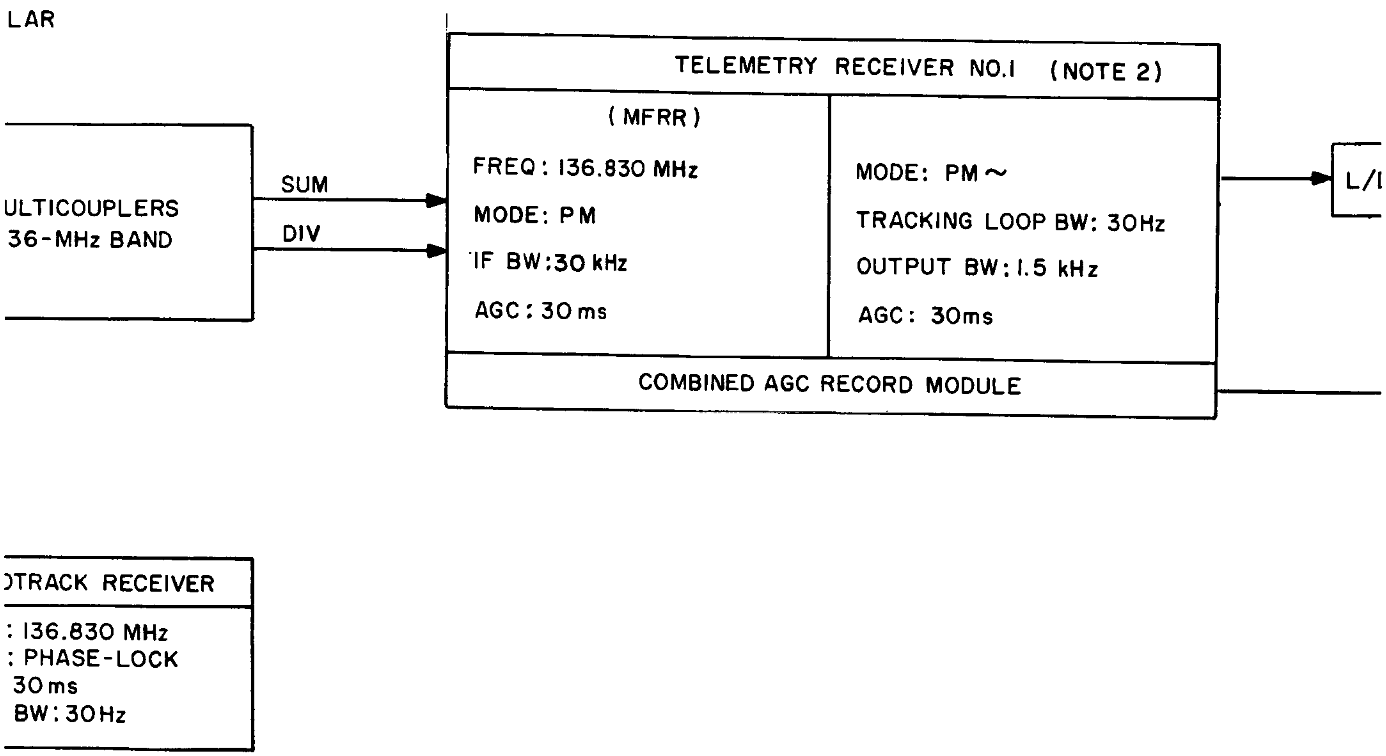
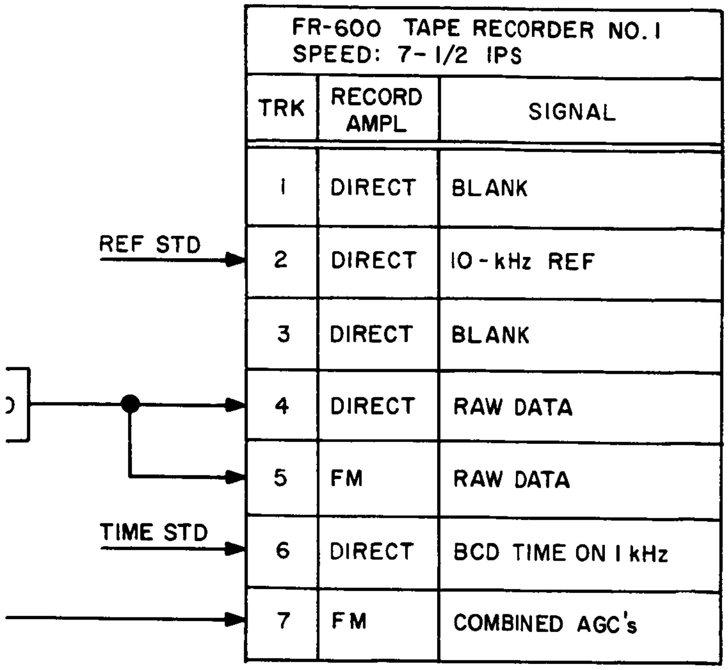


Figure 4-2. Telemetry Equipment Configuration at SEYCHL for SSS-A Support


FREQUENCY: 136-MHz BAND
MIN GAIN: 19 db
SUGGESTED POLARIZATION: CIRCU
PEDESTAL EQUIPMENT
M
AUT
FREQ
MODE
AGC:
LOOP


LAR
TELEMETRY RECEIVER NO.1 (NOTE 2)
(MFRR)
FREQ: 136.830 MHz
MODE: PM
IF BW: 30 kHz
AGC: 30 ms
MODE: PM ~
TRACKING LOOP BW: 30Hz
OUTPUT BW: 1.5 kHz
AGC: 30ms
COMBINED AGC RECORD MODULE
ULTICOUPLERS
36-MHz BAND
SUM
DIV
L/I
)TRACK RECEIVER
: 136.830 MHz
: PHASE-LOCK
30 ms
BW: 30 Hz



NOTES:

1. L/D DENOTES LINE DRIVER.
2. USE RARR LINK AND MFRR.

935-13

Figure 4-3. Telemetry Equipment Configuration at CARVON for SSS-A Support

(2) High-power transmitter. . . . 137.950 MHz (secondary)

b. Mode . . . . phase-lock

c. AGC speed . . . . 30 ms

d. Phase-lock-loop BW . . . . 30 Hz

4.6.2.3 Telemetry Receivers

The settings for the DTR and TMR-5 receivers are as follows:

Parameter	DTR With Model 215 Demod	DTR With Model 315 Demod	TMR-5 With Electrac Model 215 Demod
Frequency (MHz)			
—PCM	136.830	136.830	136.830
—Analog/PCM/CW	137.950	137.950	137.950
Tuning	std	std	std
IF Bandwidth (kHz)			
—Analog	300	300	300
—PCM	30	30	30
Gain control	AGC	combined	AGC
AGC speed	30 ms	30 ms	NA

4.6.2.4 Phase-Lock Demodulators/Diversity Combiners

The setting for the phase-lock demodulator/diversity combiner and diversity-locked phase demodulator are as follows:

Parameter	Electrac 215/215C	Electrac Model 315
Demod selector mode	PM ~	PM ~
Tracking loop bandwidth	30 Hz	30 Hz
AGC speed	30 ms	30 ms
Output bandwdith		
—446 bps PCM	1.5 kHz	1.5 kHz
—Analog	50 kHz	50 kHz

4.6.2.5 Multifunctional Receivers, Telemetry (MFRT)

The settings for the multifunctional receiver (MFRT) are as follows:

Parameter	Switch Position
Bandwidth select	130 MHz
Channel select	3683 (PCM); 3795 (analog/PCM/CW)
IF bandwidth	300 kHz (analog): 30 kHz (PCM)
AGC speed	30 ms
Tracking bandwidth	30 Hz
Demod select	PM
Tuning mode	closed loop/MAN APC
VCO select	±15 kHz
Video bandwidth	50 kHz (analog); 1.5 kHz (PCM)
TLM S/N	OFF

4.6.3 DATA RECORDING

a. Recorder type FR-600

b. Tape recorder speed

(1) Recorder 1 (PCM) . . . . . 3-3/4 ips (7-1/2 ips at CARVON)

(2) Recorder 2 (analog) . . . . . 15 ips

c. Track assignments for recorder 1 (PCM) are as follows:

Track	Record Amplifier	Signal	Signal Source
1	Direct	Detected command	Detector
2	Direct	10-kHz reference	Time standard
3	Direct	Blank	—
4	Direct	Raw PCM data	Receiver 1
5	FM	Raw PCM data	Receiver 1
6	Direct	BCD time on 1 kHz	Time standard
7	Direct	Multiplexed AGCs* and SDTC on 1 kHz	Sum amplifier
*FM recording of combined AGC's at CARVON			

d. Track assignments for recorder 2 (analog) are as follows:

Track	Record Amplifier	Signal	Signal Source
1	Direct	Detected commands	Detector
2	Direct	10-kHz reference	Time standard
3	FM	Analog data	Receiver 2
4	Direct	Blank	—
5	Direct	Analog data	Receiver 2
6	Direct	BCD time on 1 kHz	Time standard
7	Direct	Multiplexed AGCs and SDTC on 1 kHz	Sum amplifier

e. Use new or rehabilitated 1/2-inch wide, 1-1/2 mil thick magnetic tape on either a 10-1/2 or 14-inch reel. Record a maximum of one pass per tape

4.6.4 DATA HANDLING

The interface connections between the receivers and the PCM DHE are shown in Figure 4-1. Illustrations are included which present the DHE patchboard configurations. The configuration details are outlined in the following paragraphs.

4.6.4.1 Magnavox PCM DHE Configuration

The patchboard configurations of the Magnavox equipment are presented in Figures 4-4, 4-5, and 4-6. The details are as follows:

a. Signal conditioner and synchronizer

(1) Code type . . . . split-phase (SØ)

(2) Bit rate . . . . 446 bps

(3) Bandwidth . . . . wide

(4) Normal/invert . . . . normal

(5) Time constant . . . . slow

(6) Integrate and dump/filter and slice . . integrate and dump

b. Format patchboard

(1) Frame sync 1111010111100101100 110000000*

*The frame sync will be shifted by 4 bits on the format board and will start with bit 60 and end on bit 33 on the board.

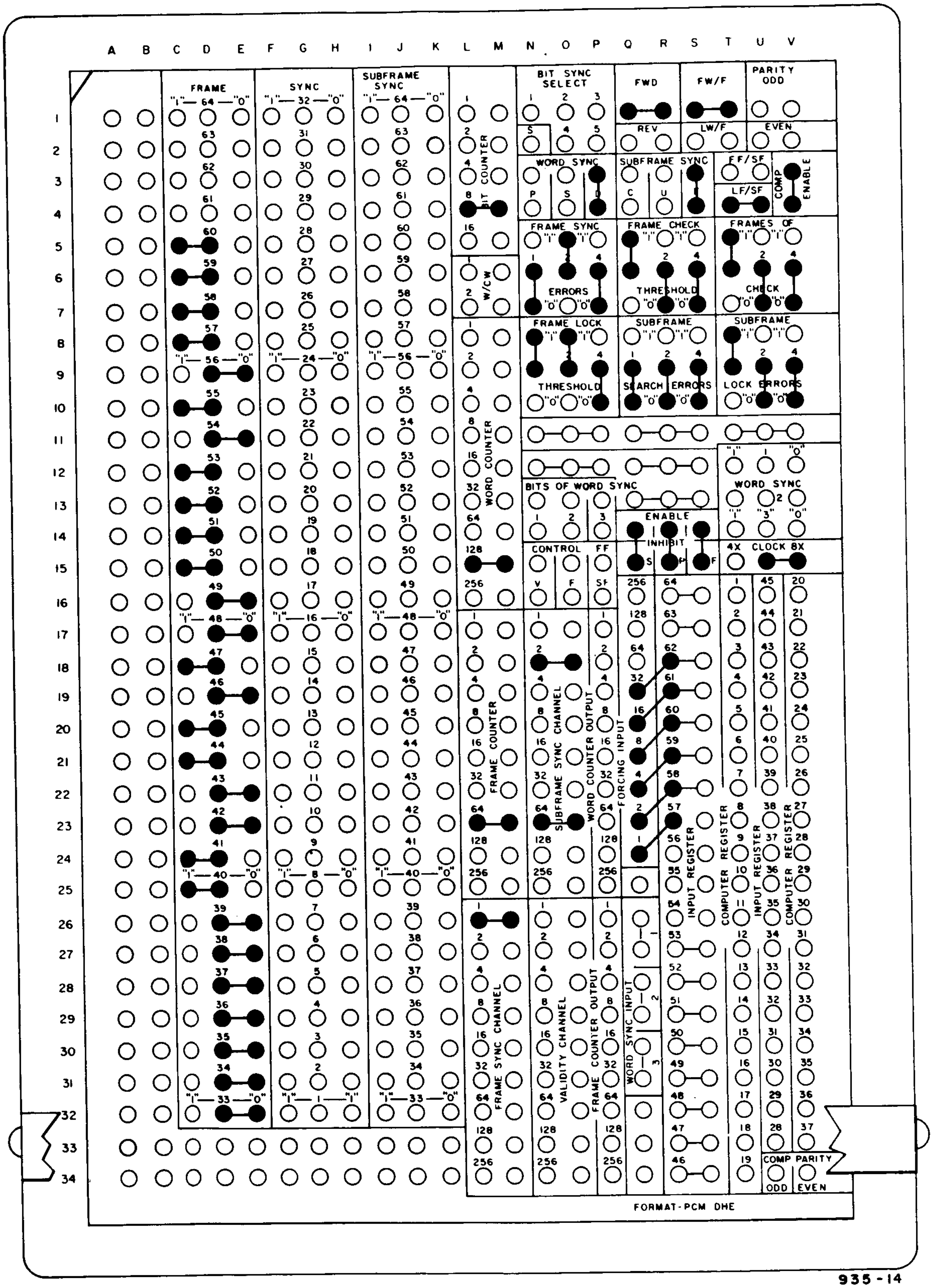


Figure 4-4. Magnavox PCM DHE Format Patchboard for the SSS-A Spacecraft

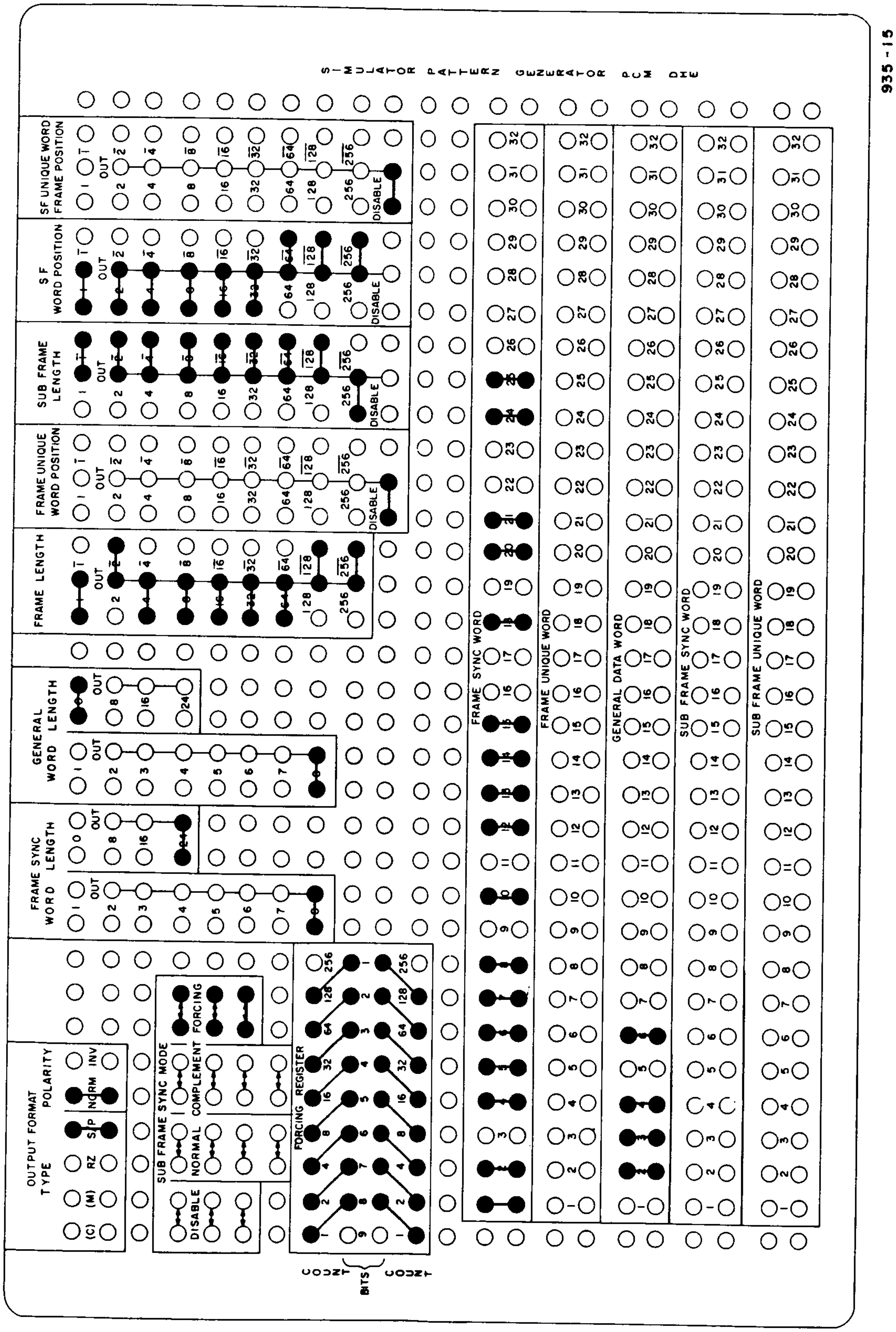


Figure 4-5. Magnavox PCM DHE Simulator Patchboard for the SSS-A Spacecraft

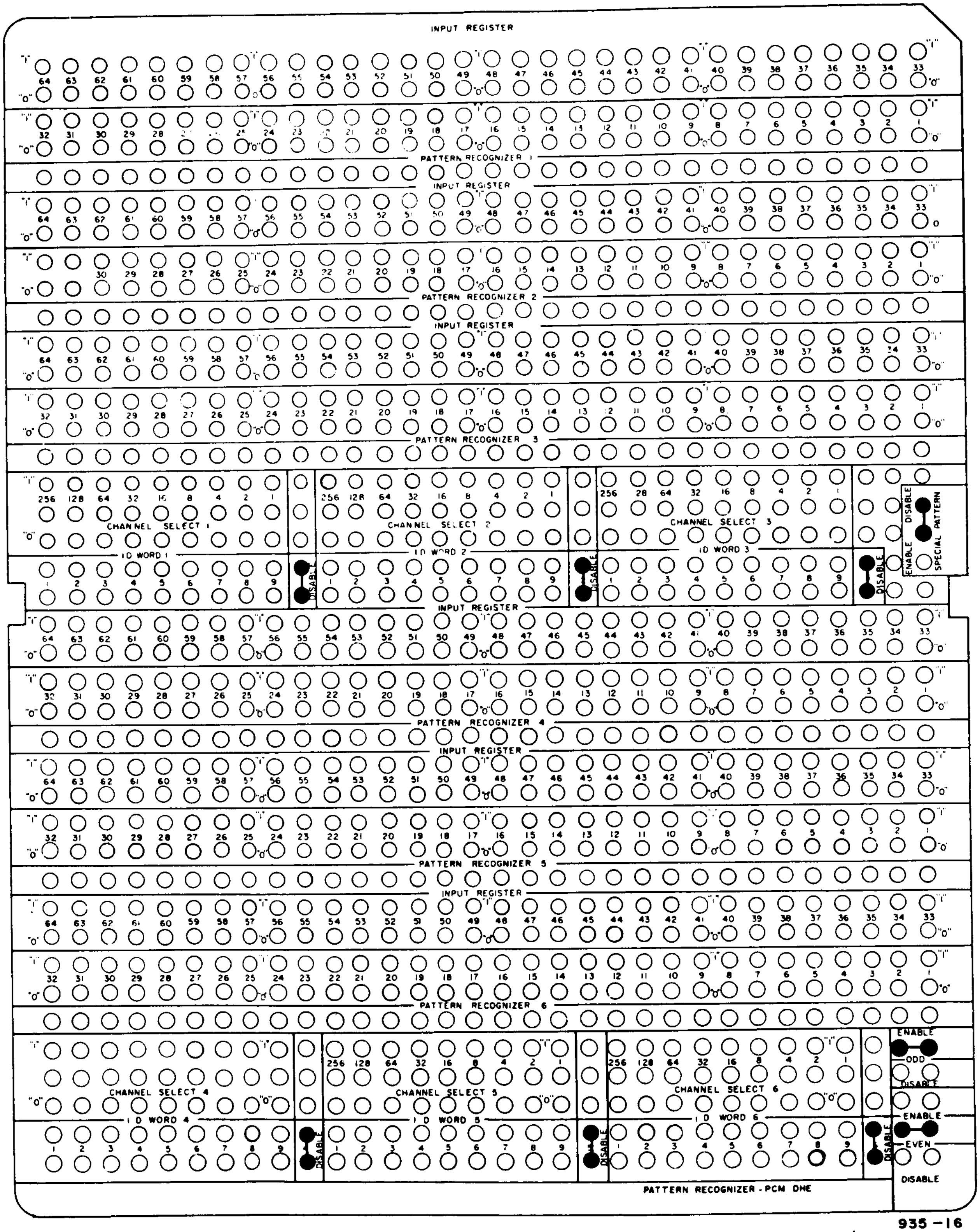


Figure 4-6. Magnavox PCM DHE Pattern Recognizer Patchboard for the SSS-A Spacecraft

(2)	Subframe sync (bit pattern) . .	no patch
(3)	Bit counter	8
(4)	W/CW (words/computer word)	no patch
(5)	Word counter	128
(6)	Frame counter	64
(7)	Frame sync channel	1
(8)	Bit sync select	no patch
(9)	Forward/reverse	FWD
(10)	FW/F — LW/F	FW/F
(11)	Parity	no patch
(12)	Word sync (P, S, or D) . . .	disable (D)
(13)	Subframe sync (type)	forcing (F)
(14)	FF/SF — LF/SF	LF/SF
(15)	Comp enable	patch
(16)	Frame sync errors	2
(17)	Frame check threshold . . .	1
(18)	Frames of check	1
(19)	Frame lock threshold . . .	3
(20)	Subframe search errors . . .	0
(21)	Subframe lock errors . . .	1
(22)	Bits of word sync	no patch
(23)	Word sync (bit pattern) . . .	no patch
(24)	Control FF	no patch
(25)	Enable — inhibit	enable S, P, and F
(26)	Clock	8X
(27)	Subframe sync channel . . .	66

(28) Validity channel . . . . . . no patch

(29) Word counter output . . . . no patch

(30) Frame counter output . . . . no patch

(31) Forcing input to input register:

Forcing Input	Input Register
1	57
2	58
4	59
8	60
16	61
32	62

(32) Word sync input . . . . none

(33) Computer register . . . . no patch

(34) Comp parity . . . . no patch

c. Simulator patchboard

(1) Output format type . . . . split-phase (S/Ø)

(2) Output format polarity . . . normal

(3) Frame sync word length . . 32 bits

(4) General word length . . . . 8 bits

(5) Frame length 125

(6) Frame unique word position . . . . disable

(7) Subframe length 256

(8) Subframe word position . . 63

(9) Subframe unique word frame position . . . . disable

(10) Subframe sync mode . . . . forcing

(11) Forcing register

Count	Bits	Bits	Count
1	8	8	1
2	7	7	2
4	6	6	4
8	5	5	8
16	4	4	16
32	3	3	32
64	2	2	64
128	1	1	128

(12) Frame sync word 110111110101111001 01100110000000

(13) Frame unique word . . . . no patch

(14) General data word 01110100

(15) Subframe sync word . . . . no patch

(16) Subframe unique word . . no patch

d. Pattern recognizer patchboard

(1) Input register . . . . no patch

(2) Pattern recognizer . . . . no patch

(3) Channel select (1 thru 6) . . no patch

(4) ID word (1 thru 6) . . . . no patch

(5) Disable (1 thru 6) . . . . disable all

(6) Odd . . . . enable

(7) Even . . . . enable

(8) Special pattern . . . . disable

e. Data word selector (refer to Table 4-2)

(1) Data position 01

(2) ID 217

(3) Frame number (word not subcommutated) . . . . XXX XXX XXX

(4) Frame number 0 . . . . . 001000000 (octal 100)

(5) Frame numbers 1 through 63 (word subcommutated) . . . frame number (octal equivalent)

(6) Word number . . . . refer to Table 4-2 (octal equivalent)

(7) SCA

(a) Word . . . . word number (octal equivalent)

(b) Frame . . . . as required

(8) SCB

(a) Word . . . . word number (octal equivalent)

(b) Frame . . . . as required

(9) Data word definition

(a) Four bit word XXXX
4 3 2 1

(b) Eight bit word XXXXXXXX
8 7 6 5 4 3 2 1

(10) Data word display

(a) MSB LSB

XX	XXX	XXX	X*
8 7	6 5 4	3 2 1	

(b) Read out in octal as follows:

(11)	(100)	(001)	X*
3	4	1	

*Ignored bit on data word selector display.

Table 4-2. Magnavox DWS Setting for SSS-A

200	001	002	003	004	005	006	007
← Parity	→ ← Frame Sync			→	FN STA		
	1111	0101 1110	0101 1001	1000 0000			
010	011	012	013	014	015	016	017
020	021	022	023	024	025	026	027
030	031	032	033	034	035	036	037
040	041	042	043	044	045	046	047
050	051	052	053	054	055	056	057
060	061	062	063	064	065	066	067
070	071	072	073	074	075	076	077
100	101	102 FR CT	103 SCA*	104 SCB*	105 STB	106	107
110	111	112	113	114	115	116	117
120	121	122	123	124	125	126	127
130	131	132	133	134	135	136	137
140	141	142	143	144	145	146	147
150	151	152	153	154	155	156	157
160	161	162	163	164	165	166	167
170	171	172	173	174	175	176	177

*Requires subframe number setting. Words not subcommutated require frame switches set to neutral position.

4.6.4.2 Radiation PCM DHE Configuration

The interface connections between the receiver and the PCM DHE are shown in the equipment configuration diagram, Figure 4-1. The configuration details for the Radiation equipment are as follows:

a. Signal conditioner

(1)	Integrate and dump/filter and slice (I & D/F & S)	I & D
(2)	Code Type (NRZ-C, NRZ-S, NRZ-M, RZ, SP)	split-phase (SØ)
(3)	Normal/invert	normal
(4)	Bandwidth (NBW, WBW) . . .	WBW
(5)	Local/remote	local
(6)	Bit rate (Kc/cps)	446 bps

b. Group synchronizer

(1)	Prime frame sync check, bit errors allowed	2
(2)	Prime frame sync check, sample checked	2
(3)	Prime frame sync lock, bit errors allowed	2
(4)	Prime frame sync lock, misses allowed	2

The punched paper tape Decommutation Program (F00254) will be prepared and forwarded to the STDN stations by the Data Handling and Display Branch, Code 814.

The data tag assignments for the display control data tag settings are listed in Table 4-3.

4.6.4.3 Dynatronics Signal Conditioner (Model 5228) Configuration

The interface connections between the receiver and the PCM DHE are shown in the equipment configuration diagram, Figure 4-1. The program patchboard

Table 4-3. SSS-A Data Tag Assignments for Radiation DHE and Dynatronics DHS

175 Parity (12	Bits) 176 1111	1 Frame Sync 0101 1110	1 0101 1001	1 1000 0000	FN 2 STA	3	4
5	6	7	10	11	12	13	14
15	16	17	20	21	22	23	24
25	26	27	30	31	32	33	34
35	36	37	40	41	42	43	44
45	46	47	50	51	52	53	54
55	56	57	60	61	62	63	64
65	66	67	70	71	72	73	74
75	76	77 FR CT	1000 SCA to 1077	2000 SCB to 2077	102 STB	103	104
105	106	107	110	111	112	113	114
115	116	117	120	121	122	123	124
125	126	127	130	131	132	133	134
135	136	137	140	141	142	143	144
145	146	147	150	151	152	153	154
155	156	157	160	161	162	163	164
165	166	167	170	171	172	173	174

←8 Bits→

NOTE: Simulator data matches data tag with readout except as follows:

Data Tag	Octal Readout
0077	000 through 377
0176	317
1000 through 1077	100 through 177
2000 through 2077	200 through 277
0001	Frame sync

is shown in Figure 4-7. The configuration details for the Dynatronics equipment are as follows:

a. PCM simulator

(1)	Sync word	11110101111001 01100110000000
(2)	Words per frame	128
(3)	Bits per word	8
(4)	Code type	split-phase (SØ)
(5)	Bit rate	446 bps
(6)	Polarity	positive

b. Signal conditioner

(1)	Input selector	receiver 1
(2)	Input level (set level on meter)	as required
(3)	Coarse bit rate mult	446 bps
(4)	Coarse bit rate	
(5)	Bandwidth	wide
(6)	Code type	split-phase (SØ)
(7)	Polarity (pos/neg)	positive

4.6.4.4 Dynatronics PCM DHS Configuration

Program F00251 will be used for the simulator and Program F00252 for the decommutator. The switch and control settings for the Dynatronics PCM DHS equipment are as follows:

a. Simulator system control panel

(1)	Program select	local
(2)	Mode select	sim
(3)	Memory address	0003

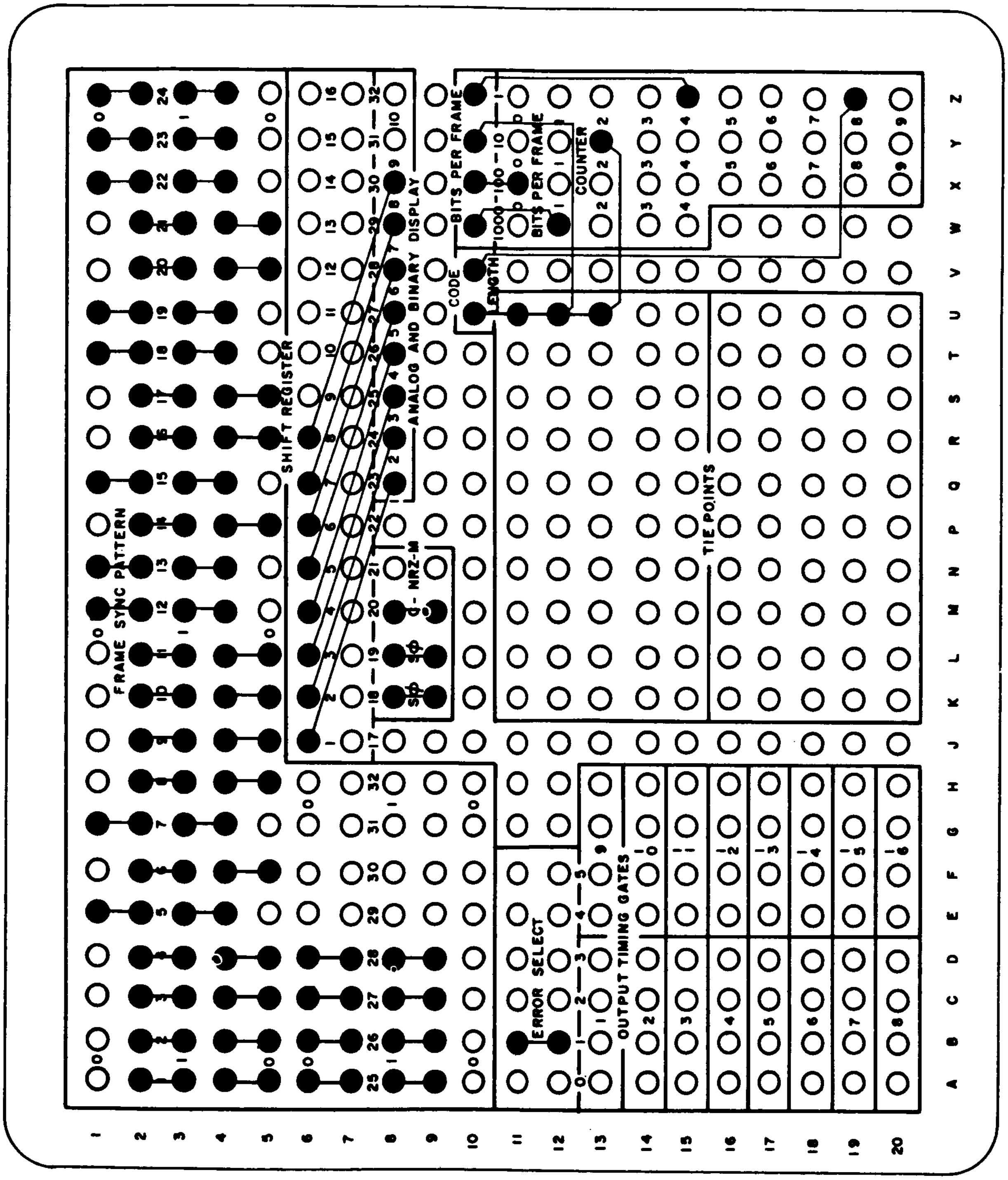


Figure 4-7. Dynatronics (Model 5228) Patchboard for the SSS-A Spacecraft

b. Simulator analog control panel

(1)	Bit rate	program or as required
(2)	Bit rate, fine freq	to top center
(3)	Code type	program or as required
(4)	Db S/N ratio	program
(5)	Db S/N ratio, calibrate . .	off
(6)	Blanking	off

c. Decommutator system control panel

(1)	Data source	bit sync
(2)	Start source	local
(3)	Mode select	decom

d. Decommutator memory display panel start address 0003

e. Decommutator peripheral control panel

(1)	Sync validity	all switches off (not illuminated)
(2)	Computer override	all switches off (not illuminated)
(3)	Event relays	switch off (illuminated)

For display control data tag settings, use the SSS-A data tag assignments listed in Table 4-3.

4.6.5 REAL-TIME DATA TRANSMISSIONS PROCEDURES

The STDN stations (except SEYCHL and CARVON) providing telemetry support to the SSS-A mission have the capability to transmit selected 446-bps real-time spacecraft PCM data to GSFC via the data transmission system (DTS). In addition, ROSMAN has the capability to receive the wideband analog data and to relay them to GSFC via the microwave link. The NASCOM real-time data transmission system (DTS) configuration for the PCM data link is presented in the following paragraphs.

4.6.5.1 DTS Signal Conditioners

The settings for the Vector or EMR signal conditioner used with the DTS are as follows:

Parameter	Vector Signal Conditioner	EMR Signal Conditioner
Code	split-phase (SØ)	SØC
Integrate	100	NA
Loopwdith/BW	3%	3%
Filter	—	RST INT
Bit rate	446 bps	446 bps
Tracking	NA	3%
Polarity	normal	normal

4.6.5.2 DTS Encoders

The configuration for the E-9 and E-111 DTS encoders are provided in the following paragraphs.

a. DTS encoder, Model E-9 — see Figure 4-8 for DTS program patch-board for SSS-A.

   (1) NASCOM block length 1200

   (2) Serial data . . . . ON

   (3) Time tag . . . . ON

   (4) Auxiliary data . . . . OFF

   (5) Header

      (a) Source . . . . NA

      (b) Destination . . . . NA

      (c) Format . . . . NA

b. DTS encoder, Model E-111

   (1) AC power . . . . ON

   (2) Header . . . . NA

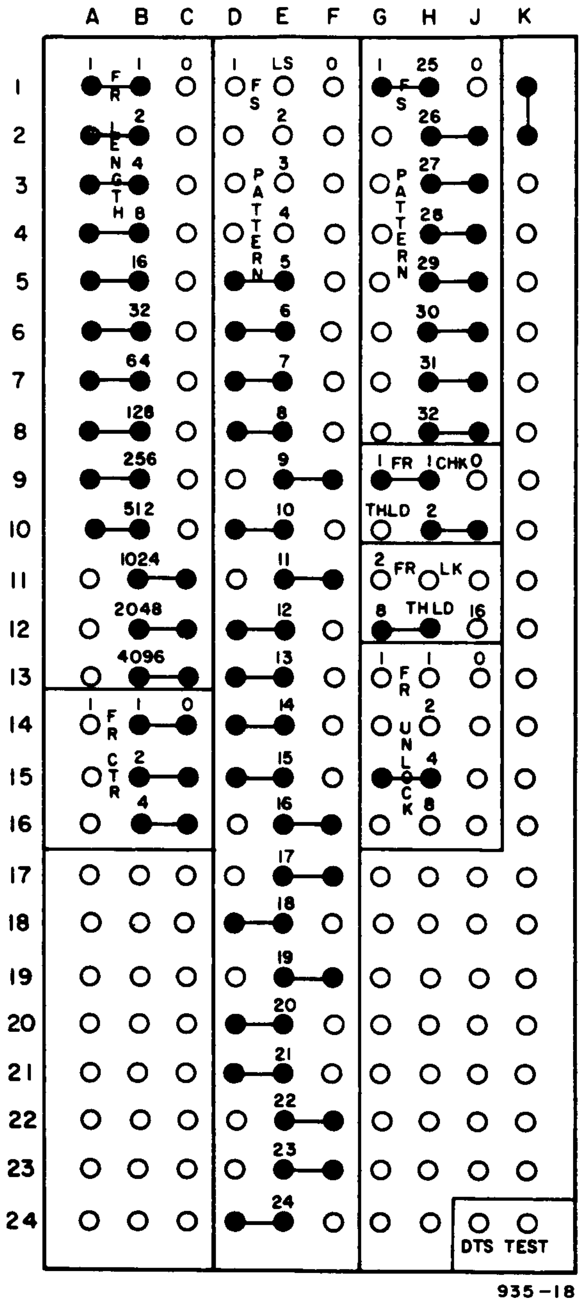


Figure 4-8. DTS Program Patchboard for the SSS-A Spacecraft

(3) Serial data . . . . ON

(4) Auxiliary data . . . . OFF

(5) TIME GO . . . . ON

4.6.5.3 Astrodata Time Code Translator for DTS

The Astrodata time code translator for the DTS consists of a universal time code translator, Model 6220-723, and a dc code module, Model 6220-1300. The settings for these units are as follows:

a. Universal time code translator, Model 6220-723

(1) Input (NORMAL/ INVERTED) . . . . NORMAL

(2) Sync

(a) Translator (TRANS). . . . not used

(b) Frame bypass (1 thru 7) . . 2

(c) Generator (GEN) . . . not used

(3) Carrier filter

(a) Playback . . . . NORM

(b) Search . . . . NORM

(4) Mode (REMOTE/LOCAL) . . . LOCAL

(5) Local control (MAG/GEN) . . . GEN

b. DC code module, Model 6220-1300 (plug-in assembly)

(1) Coarse frequency (0.2/.15/1/7/50 kHz)

(a) Search . . . . not used

(b) Playback 15/1

(2) Pulse rate (.7/4/25/150/900/5400 pps)

(a) Search . . . . not used

(b) Playback 25/150

(3) AC FAILSAFE/AC/DC . . . AC FAILSAFE

4.6.5.4 Datatron Time Code Translator for DTS

The Datatron time code translator for the DTS consists of a time code translator/generator (Model 3000), a tape search unit (Model 3400-106), and a dc code failsafe unit (Model 3600-101). The settings for these units are as follows:

a. Time code translator/generator, Model 3000

   (1) Mode

      (a) Frame bypass (0, 1, 2, 4, 8, and ∞) 2

      (b) Code select (1, 2, 3, 4, 5, and 6) . . . . 2 (NASA 36)

   (2) Filters

      (a) Playback . . . . NOR

      (b) Search . . . . NOR

   (3) Fwd/rev . . . . FWD

b. Tape search unit, Model 3400-106 — not used to transmit real-time data

c. DC code Failsafe Unit, Model 3600-101

   (1) Code to carrier ratio (10:1, 50:1, 100:1) . . . . NA

   (2) Playback

      (a) Pulse rate (.5/5/25/150/1000/6400 pps) 25/150

      (b) Coarse frequency (.02/.15/.8/5/20/64 kHz) 8/5

   (3) Search

      (a) Pulse rate . . . . not required

      (b) Coarse frequency . . . . . not required

   (4) Mode select (DC/AC/AC FAILSAFE) . . . . AC FAILSAFE

   (5) Input (NEG/POS) . . . . . as required

4.6.6 POSTPASS DATA TRANSMISSION PROCEDURES

The STDN stations may be required to play back portions of the recorded PCM data to GSFC via the DTS. The postpass playback configuration is shown in Figure 4-9 and is detailed in the following paragraphs.

4.6.6.1 DTS Signal Conditioners

The settings for the Vector or EMR signal conditioner used with the DTS are as follows:

Parameter	Vector Signal Conditioner	EMR Signal Conditioner
Code	split-phase (SØ)	SØC
Integrate	100	NA
Loopwidth/BW	3%	3%
Filter	—	RST INT
Bit rate	1784 bps	1.784 kbps
Tracking	NA	3%
Polarity	normal	normal

4.6.6.2 DTS Encoders

The configuration for the E-9 DTS encoder for postpass data transmission are provided in the following paragraphs.

a. DTS Encoder, Model E-9 — see Figure 4-8 for DTS program patchboard for SSS-A.

(1) NASCOM block length . . . none

(2) Serial data . . . . ON

(3) Time tag . . . . ON (tape replay)

(4) Auxiliary data . . . . OFF

(5) Header

(a) Source . . . . NA

(b) Destination . . . . NA

(c) Format . . . . NA

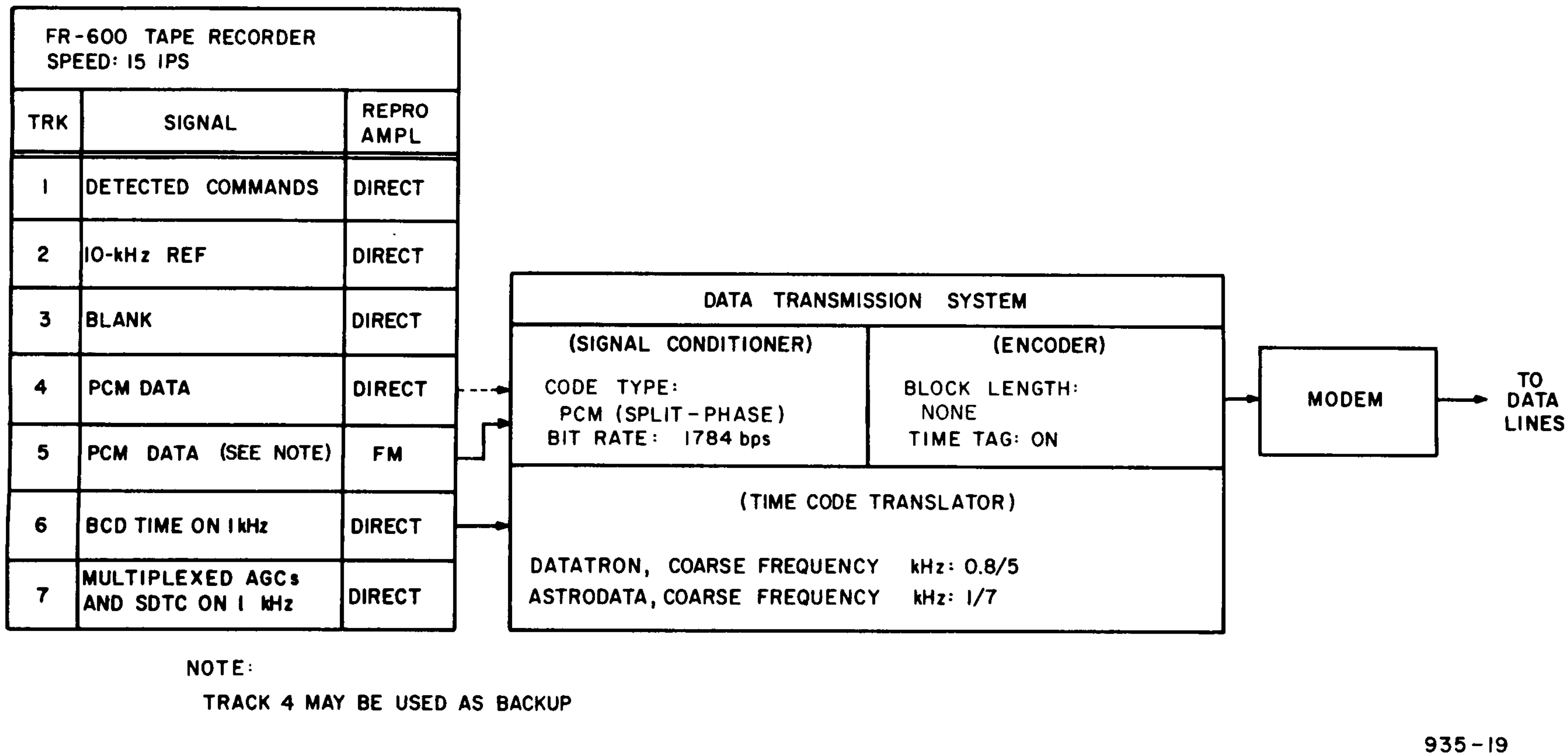


Figure 4-9. Equipment Configuration for Postpass Transmission of Data to GSFC

b. DTS encoder, Model 6-111

(1) AC power . . . . ON

(2) Header . . . . NA

(3) Serial data . . . . ON

(4) Auxiliary data . . . . OFF

(5) TIME GO . . . . ON

4.6.6.3 Astrodata Time Code Translator for DTS

The Astrodata time code translator for the DTS consists of a universal time code translator, Model 6220-723 and a dc code module, Model 6220-1300. The settings for these units are as follows:

a. Universal time code translator, Model 6220-723

(1) Input (NORMAL/INVERTED) . . NORMAL

(2) Sync mode

(a) Translate (TRANS) . . . not used

(b) Frame bypass (1 thru 7) . . 2

(c) Generator (GEN) . . . not used

(3) Carrier filter

(a) Playback . . . . 4 kHz

(b) Search . . . . as required

(4) Mode (REMOTE/LOCAL) . . . LOCAL

(5) Local control (MAG/GEN) . . . MAG

b. DC code module, Model 6220-1300 (plug-in assembly)

(1) Coarse frequency (.02/.15/1/7/50 kHz)

(a) Search . . . . as required

(b) Playback 1/7

(2) Pulse rate (.7/4/25/150/900/5400 pps)

(a) Search . . . . as required

(b) Playback 150/900

(3) AC FAILSAFE/AC/DC . . . AC

4.6.6.4 Datatron Time Code Translator for DTS

The Datatron time code translator for the DTS consists of a time code translator/generator (Model 3000), a tape search unit (Model 3400-106), and a dc fail-safe unit (Model 3600-101). The settings for these units are as follows:

a. Time code translator/generator, Model 3000

(1) Mode

(a) Frame bypass (0, 1, 2, 4, 8, and ∞) 2

(b) Code select (1, 2, 3, 4, 5, and 6) . . . . 2 (NASA 36)

(2) Filters

(a) Playback . . . . 4 kHz

(b) Search . . . . as required

(3) Fwd/rev . . . . FWD

b. Tape search unit, Model 3400-106 — the control settings for this unit will be determined by station operating personnel as the operational requirements dictate.

c. DC code failsafe unit, Model 3600-101

(1) Code to carrier ration . . . NA

(2) Playback

(a) Pulse rate (.5/5/25/150/1000/6400 pps) 150/1000

(b) Coarse frequency (.02/.15/.8/5/20/64 kHz) 8/5

(3) Search

(a) Pulse rate . . . . as required

(b) Coarse frequency . . . as required

(4) Mode select (DC/AC/AC FAILSAFE) . . . . AC

(5) Input (NEG/POS) . . . . . as required

4.7 COMMAND EQUIPMENT SUPPORT

The equipment configuration for command support of the SSS-A spacecraft is shown in Figure 4-1. A special SSS/IMP spacecraft command encoder will provide the PCM commands which conform to the GSFC Aerospace Data Systems Standards. The encoder will operate in the manual, data link, or paper tape mode. The PCM commands are presented in Table 4-4 which includes manual and paper tape codes. The SSS/IMP command encoder format for the manual mode is presented in Figure 4-10. The SSS/IMP encoder format for the paper tape program load mode is shown in Figure 4-11. The SSS/IMP command encoder setup instructions are available in OM-573-XXXI. The paper tape command mode and tape punch code are shown in Figure 4-12.

When using the manual mode of the SSS/IMP encoder to transmit commands, the CLEAR pushbutton must be pressed prior to setting in a new command and pressing the TRANSMIT pushbutton. For each critical command, the CLEAR pushbutton and the CC ENABLE pushbutton must be pressed prior to setting in a new command and pressing the TRANSMIT pushbutton.

The backup tone-sequential command functions are presented in Table 4-5. The instructions for setup of the CSC command encoder for tone-sequential commands are presented in Table 4-6.

The ROSMAN and QUITOE stations will be equipped with the PCM command bit sync unit which permits these stations to receive and relay digital commands, via voice/data link, from the GSFC control center computer to the spacecraft. This capability will be used primarily for spacecraft program memory loading operations. Normally, PCM spacecraft commands will be sent by manual or paper tape mode from the PCM command console.

Each PCM encoder will be equipped with a printer to provide a permanent record of each PCM command transmitted by the station, along with the time of the transmission.

The pertinent ground equipment parameters are as follows:

a. Frequency . . . . 148.980 MHz

b. Antenna

   (1) Gain, minimum . . . . +13 db

   (2) Polarization, suggested . . . right-hand circular

c. Transmitter*

   (1) Power, minimum . . . . . 200 watts

   (2) Type of modulation . . . . . AM

   (3) Modulation factor 80%

d. SSS/IMP encoder (primary)

   (1) Command mode . . . . PCM/FSK — AM/AM

   (2) Frame length . . . . 64 bits

   (3) Bit rate . . . . 128 bps

   (4) FSK subcarriers

      (a) ZERO . . . . 9,000 Hz

      (b) ONE . . . . 9,640 Hz

   (5) SSS-A address SWS (octal) . . . 0606

e. CSC command encoder (backup)

   (1) Command mode . . . . tone-sequential (PCM/AM/AM)

   (2) SSS-A address code 1203

   (3) SSS-A execute (3 tones per command) 1003 1006 1010

*The use of SATAN transmitter is requested when the spacecraft is at or near apogee.

PCM Command No. (Octal)	Command Function	Literal Equiv
000*	Channeltron mult high-voltage on/off	CHNLTRN HV
001	DC electric fields, polarity	DC EL FLDS P
002*	Separation	SEPARAT
003	Spare	SPARE
004	DC electric fields, gain shift	DC EL FLDS G
005	Spare	SPARE
006	Spare	SPARE
007	Optical aspect on	OPTIC ASPCT
010	Channeltron mult staircase mode select	CHNLTRN STR
011	Spare	SPARE
012	Channeltron mult B and D discriminator level	CHLTRN BD D
013*	SCADS on	SCADS ON
014	SS electron detector gain change	SS EL DET GN
015	Spare	SPARE
016	SCADS off	SCADS OFF
017	ASCS spin up	ASCS SPIN UP
020	Spare	SPARE
021	Battery charge enable	BATT CHRG E
022	Data transmitter on	DATA XMTR O
023	Solid-state electron detector experiment on	SS EL DET EX
024	Spare	SPARE
025	ASCS spin down	ASCS SPIN DO
026	Spare	SPARE
027	SCADS threshold A	SCADS THRSH
030	Spare	SPARE
031	SCADS threshold B	SCADS THRSH
032	Solid-state electron detector experiment off	SS EL DET EX
033	Solid-state proton detector experiment on	SS PTN DET E
034	Solid-state proton detector experiment off	SS PTN DET E

*Critical commands Notes: 1. Verifications left blank will be verified by MSC

ıIent	SSS/IMP Command Encoder PCM Command Codes							Magnavox DV Frame/Wo:	
	Manual Mode Thumbwheel Switch Settings			Paper Tape Mode Format					
	Fill Code	Cmd	Address (including Mode)	Check Code	Fill Code	Cmd	Address (including Mode)	Data Mode and PGM Load Mode	A Su
)N/OFF	002616624	000*	0606	736	616624	000	0606	—	
LRT		001		176		001		—	
		002*		022		002		041/103	
		003		662		003		—	
N SFT		004		312		004		—	
		005		552		005		—	
		006		406		006		—	
ON		007		246		007		012/104	
CS SEL		010		572		010		—	
		011		332		011		—	
3CR LVL		012		266		012		—	
		013*		426		013		011/104	
CHNG		014		156		014		—	
		015		716		015		—	
		016		642		016		011/104	
		017		002		017		050/104	
		020		226		020		—	
NABL		021		466		021		007/104	
N		022		532		022		—	
P ON		023		372		023		011/104	
		024		602		024		—	
VN		025		042		025		050/104	
		026		116		026		—	
.D A		027		756		027		—	
		030		062		030		—	
.D B		031		622		031		—	
P OFF		032		776		032		011/104	
XP ON		033		136		033		010/104	
XP OFF	002616624	034	0606	446	616624	034	0606	010/104	

)CC. 2. Refer to table 1-5. 3. N indicates neutral 4. Alternate method of command ver is OFF. On Magnavox DWS, use

Table 4-4. SSS-A PCM Commands

Telemetry Verification				
VS rd	Radiation/Dynatronics Data Tags		Word Identification	Remarks
ccelerated bcom Mode	Data Mode and PGM Load Mode	Accelerated Subcom Mode		
—	—	—	—	
—	—	—	—	
N/066	1041	0063	A34	All zeros
—	—	—	—	
—	—	—	—	
—	—	—	—	
—	—	—	—	
N/153	2012	0150	B11	8-bit readout (see note 2)
—	—	—	—	
—	—	—	—	
—	—	—	—	
N/155	2011	0152	B10	8-bit readout (see notes 2 and 4)
—	—	—	—	
—	—	—	—	
N/155	2011	0152	B10	8-bit readout (see notes 2 and 4)
N/051	2050	0046	B41	Bit 8 = 0, Bit 7 = 1, Bit 6 = 1
—	—	—	—	
N/161	2007	0156	B8	8-bit readout (see note 2)
—	—	—	—	AOS 136.830 MHz
N/155	2011	0152	B10	8-bit readout (see note 2)
—	—	—	—	
N/051	2050	0046	B41	Bit 8 = 0, Bit 7 = 1, Bit 6 = 0
—	—	—	—	
—	—	—	—	
—	—	—	—	
—	—	—	—	
N/155	2011	0152	B10	8-bit readout (see note 2)
N/157	2010	0154	B9	8-bit readout (see note 2)
N/157	2010	0154	B9	8-bit readout (see note 2)

·ification. STB Bit 5 = 1 SCADS power is ON. STB Bit 5 = 0 SCADS power
frame word N/105. On Radiation/Dynatronics, use data tag 0102.

PCM Command No. (Octal)	Command Function	Literal Equi
035*	ASCS attitude plus	ASCS ATT PLUS
036	SCADS threshold C	SCADS THRSHLI
037	Battery charge disable	BATT CHRG DIS
040	Data transmitter low power	DATA XMTR LC
041	SCADS reset	SCADS RESET
042	AC electric fields time constant	AC EL FLDS TC
043	Magnetometer zero crossing	MGTMTR ZERO
044	Channeltron mult half/full roll sync	CHNLTRN RLL
045	Channeltron mult A and C discriminator level	CHLTRN AC DS(
046	DC electric fields experiment off	DC EL FLDS EX
047	Spare	SPARE
050*	Channeltron experiment on	CHNLTRN EXP
051	Optical aspect off	OPTIC ASPCT O
052	Channeltron experiment off	CHNLTRN EXP
053	Channeltron mult B able/disable	CHLTRN B ABL,
054	Magnetometer search coils range	MGTMTR SRCH
055	Magnetometer flux gates high-low range	MGTMTR FLX H
056*	Arm separation and despin circuits	ARM SEP DSPN
057	Disarm separation and despin circuits	DISARM SEP DS
060	AC electric fields experiment on	AC EL FLDS EX
061	AC electric fields experiment off	AC EL FLDS EX
062	AC electric fields reset	AC EL FLDS RE
063*	ASCS attitude minus	ASCS ATT MINU
064	Spare	SPARE
065	SS proton detector normal/low energy mode	SS PTN DET NR
066	Magnetometer experiments on	MGTMTR EXP C
067	Magnetometer experiments off	MGTMTR EXP C
070	Data transmitter off	DATA XMTR OF
071	Buss detector disable	BUS DET DISAB

*Critical commands Notes: 1. Verifications left blank will be verified by MSOC

valent	SSS/IMP Command Encoder PCM Command Codes								
	Manual Mode Thumbwheel Switch Settings			Paper Tape Mode Format				Magnavox DWS Frame/Word	
	Fill Code	Cmd	Address (including Mode)	Check Code	Fill Code	Cmd	Address (including Mode)	Data Mode and PGM Load Mode	Ac Sub
	002616624	035*	0606	206	616624	035	0606	050/104	I
) C		036		352		036		—	
ABL		037		512		037		007/104	I
W-PWR		040		702		040		—	
		041		142		041		—	
		042		016		042		—	
CROSNG		043		656		043		050/104	I
SYNC		044		326		044		—	
R LVL		045		566		045		—	
P OFF		046		432		046		012/104	I
		047		272		047		—	
ON		050*		546		050		011/104	I
FF		051		306		051		012/104	I
OFF		052		252		052		011/104	I
/DSBL		053		412		053		—	
CL RNG		054		162		054		054/104	I
/L RNG		055		722		055		050/104	I
		056*		676		056		054/104	I
PN		057		036		057		054/104	I
P ON		060		212		060		012/104	I
P OFF		061		452		061		012/104	I
SET		062		506		062		—	
S		063*		346		063		050/104	I
		064		636		064		—	
M/LOW		065		076		065		—	
N		066		122		066		010/104	I
FF		067		762		067		010/104	I
F		070		056		070		—	
L	002616624	071	0606	616	616624	071	0606	007/104	I

C. 2. Refer to table 1-5. 3. N indicates neutral

Table 4-4. SSS-A PCM Commands (Cont)

Telemetry Verification					
;	Radiation/Dynatronics Data Tags		Word Identification	Remarks
:elerated :om Mode	Data Mode and PGM Load Mode	Accelerated Subcom Mode		
√/051	2050	0046	B41	Bit 8 = 1, Bit 7 = 0, Bit 6 = 1
—	—	—	—	
√/161	2007	0156	B8	8-bit readout (see note 2)
—	—	—	—	
—	—	—	—	
—	—	—	—	
√/051	2050	0046	B41	Bit 5 = 1
—	—	—	—	
—	—	—	—	
√/153	2012	0150	B11	8-bit readout (see note 2)
—	—	—	—	
√/155	2011	0152	B10	8-bit readout (see note 2)
√/153	2012	0150	B11	8-bit readout (see note 2)
√/155	2011	0152	B10	8-bit readout (see note 2)
—	—	—	—	
√/041	2054	0036	B45	Bit 2: 1 = high, 0 = low
√/051	2050	0046	B41	Bit 1: 1 = high, 0 = low
√/041	2054	0036	B45	Bit 5 = 1
√/041	2054	0036	B45	Bit 5 = 0
√/153	2012	0150	B11	8-bit readout (see note 2)
√/153	2012	0150	B11	8-bit readout (see note 2)
—	—	—	—	
√/051	2050	0046	B41	Bit 8 = 1, Bit 7 = 0, Bit 6 = 0
—	—	—	—	
—	—	—	—	
√/157	2010	0154	B9	8-bit readout (see note 2)
√/157	2010	0154	B9	8-bit readout (see note 2)
—	—	—	—	LOS 136.830 MHz
√/161	2007	0156	B8	8-bit readout (see note 2)

PCM Command No. (Octal)	Command Function	Literal Equival
072	Experiment transmitter on	EXP XMTR ON
073	Experiment transmitter off	EXP XMTR OFF
074	SS proton detector anticoincidence/not-anticoincidence mode	SS DET ANTI/CO
075	SS proton detector high/low gain mode	SS PTN DET H/L
076	DC electric fields experiment on	DC EL FLDS EXI
077	Spare	SPARE
100	Data mode	DATA MODE
101	SS electron detector bias change	SS EL DET BS CH
102	Spare	SPARE
103	Program load mode	PGM LOAD MODI
104	Accelerated subcom mode	ACCL SUBCOM M
105	Channeltron mult D able/disable	CHLTRN D ABL/
106*	ASCS direct attitude on	ASCS DRCT ATT
107*	Battery discharge able	BATT DSCHRG A
110	SS electron detector half/full roll sync	SS EL DET RLL S
111	Channeltron mult Z axis proton	CHLTRN Z AX PI
112	Data transmitter reset	DATA XMTR RES
113*	Battery discharge disable	BATT DSCHRG D
114	Channeltron mult Z axis electron	CHLTRN Z AX EI
115	ASCS off	ASCS OFF
116	Experiments able	EXPS ABL
117	Sun pulse sync	SUN PLSE SYNC

*Critical commands Notes: 1. Verifications left blank will be verified by MSOC

ent	SSS/IMP Command Encoder PCM Command Codes							Magnavox DW Frame/Word	
	Manual Mode Thumbwheel Switch Settings			Paper Tape Mode Format					
	Fill Code	Cmd	Address (including Mode)	Check Code	Fill Code	Cmd	Address (including Mode)	Data Mode and PGM Load Mode	Ac Sub
	002616624	072	0606	742	616624	072	0606	010/104	
		073		102		073		010/104	
N		074		472		074		—	
GN		075		232		075		—	
ON		076		366		076		012/104	
		077		526		077		—	
		100		746		100		N/005	
NG		101		106		101		—	
		102		052		102		—	
		103		612		103		N/005	
ODE		104		362		104		N/005	
DSABL		105		522		105		—	
ON		106*		476		106		050/104	
BL		107*		236		107		007/104	
YNC		110		502		110		—	
ROTON		111		342		111		—	
ET		112		216		112		—	
ISABL		113*		456		113		007/104	
CTRN		114		126		114		—	
		115		766		115		050/104	
		116		632		116		007/104	
	002616624	117	0606	072	616624	117	0606	050/104	

. 2. Refer to table 1-5. 3. N indicates neutral

Table 4-4. SSS-A PCM Commands (Cont)

Telemetry Verification				
S	Radiation/Dynatronics Data Tags		Word Identification	Remarks
celerated com Mode	Data Mode and PGM Load Mode	Accelerated Subcom Mode		
N/157	2010	0154	B9	8-bit readout (see note 2)
N/157	2010	0154	B9	8-bit readout (see note 2)
—	—	—	—	
—	—	—	—	
N/153	2012	0150	B11	8-bit readout (see note 2)
—	—	—	—	
N/005	0002	0002	FN/STA	Bit 3 = 1
—	—	—	—	
—	—	—	—	
N/005	0002	0002	FN/STA	Bit 4 = 1
N/005	0002	0002	FN/STA	Bit 2 = 1
—	—	—	—	
N/051	2050	0046	B41	Bit 8 = 1, Bit 7 = 1, Bit 6 = 0
N/161	2007	0156	B8	8-bit readout (see note 2)
—	—	—	—	
—	—	—	—	
—	—	—	—	
N/161	2007	0156	B8	8-bit readout (see note 2)
—	—	—	—	
N/051	2050	0046	B41	Bit 8 = 1, Bit 7 = 1, Bit 6 = 1
N/161	2007	0156	B8	8-bit readout (see note 2)
N/051	2050	0046	B41	Bit 5 = 0

Table 4-5. SSS-A Backup Tone-sequential Commands

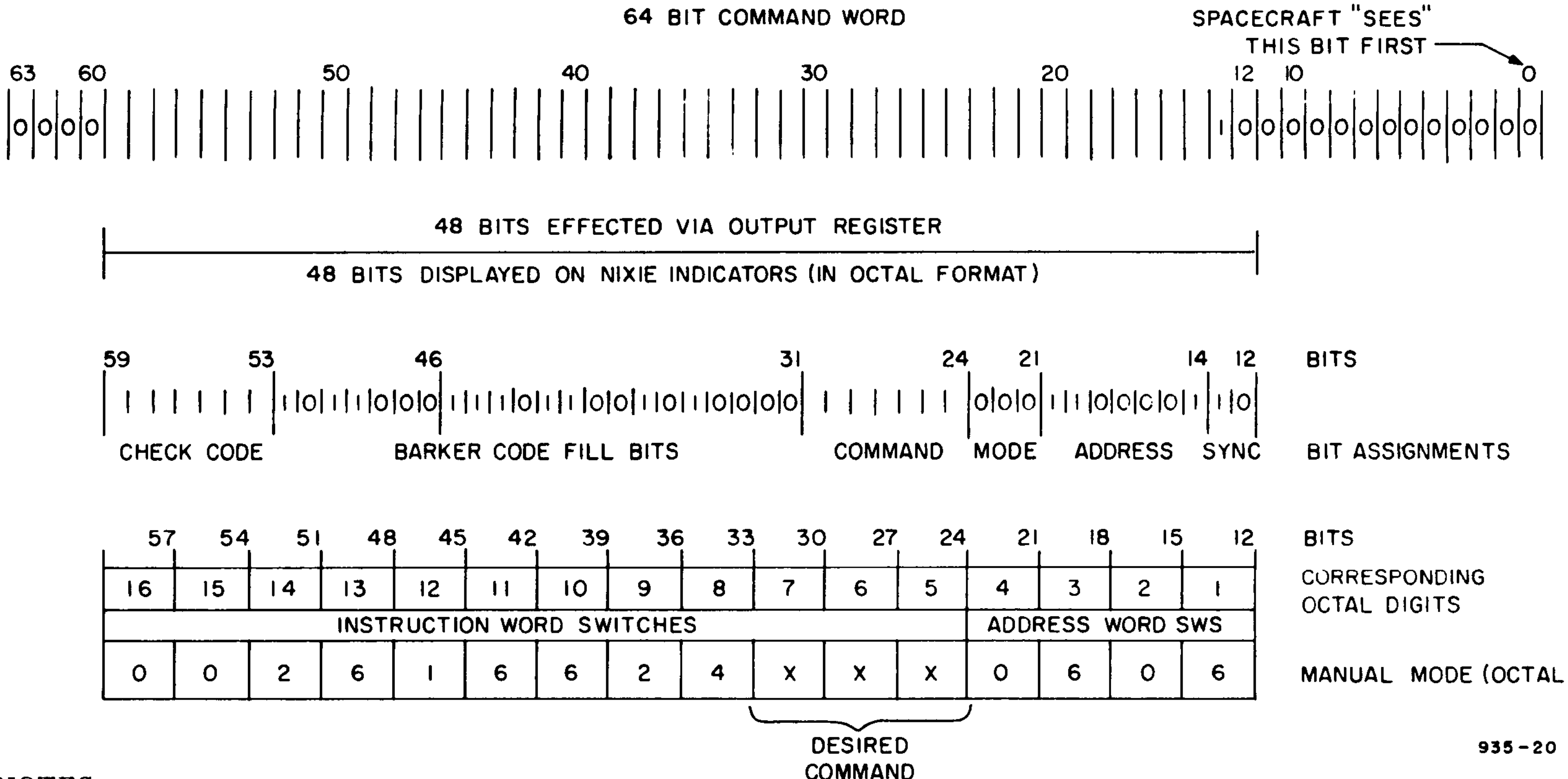
Letter Code	Command Function	Literal	CSC Console Code (Address 1203)	Baudot Code	Verification
AAB	Spare		1003 1003 1006	NA RA RA RI	—
AAC	Spare		1003 1003 1010	RA RA RR	—
ABA	Experiments able	EXPS ABL	1003 1006 1003	RA RI RA	Same as PCM cmd 116
ABC	Killer	KILLER	1003 1006 1010	RA RI RR	LOS 136.830 MHz
ACA	Spare		1003 1010 1003	RA RR RA	—
ACB	ASCS direct attitude on	ASCS DRCT ATT ON	1003 1010 1006	RA RR RI	Same as PCM cmd 106
BAB	SS proton detector experiment on	SS PTN DET EXP ON	1006 1003 1006	RI RA RI	Same as PCM cmd 033
BAC	Spare		1006 1003 1010	RI RA RR	—
BBA	Experiment transmitter direct modulation	EXP XMTR DIR MOD	1006 1006 1003	RI RI RA	Analog data on 137.950 MHz
BBC	Spare		1006 1006 1010	RI RI RR	—
BCA	Data transmitter reset	DATA XMTR RESET	1006 1010 1003	RI RR RA	Same as PCM cmd 112
BCB	Magnetometer experiments on	MGTMTR EXP ON	1006 1010 1006	RI RR RI	Same as PCM cmd 066
CAB	Data transmitter on	DATA XMTR ON	1010 1003 1006	RR RA RI	Same as PCM cmd 022
CAC	Spare		1010 1003 1010	RR RA RR	—
CBA	ASCS off	ASCS OFF	1010 1006 1003	RR RI RA	Same as PCM cmd 115
CBC	Spare		1010 1006 1010	RR RI RR	—
CCA	Experiment transmitter data mode (PCM)	EXP XMTR PCM MODE	1010 1010 1003	RR RR RA	PCM data on 137.950 MHz
CCB	Spare		1010 1010 1006	NA RR RR RI	

Notes: Address tone - 5790 Hz
Execute tone A - 2270 Hz
Execute tone B - 3000 Hz
Execute tone C - 3621 Hz

Table 4-6. Instructions for Setup of the CSC Command Encoder for Backup Operation of the SSS-A Spacecraft

Switch Number	Switch Nomenclature	Function	Position for Manual Mode	Position for Automatic Mode
1	Mode	Select mode	T	P
2	Code	Tone-sequential	4	4
3	SEQ	$T_1 + T_2 + T_3 + T_4$	7	Paper-tape controlled
4	Address	NA	NA	
5	1st frame	Address tone	1203	
6	2nd frame	Execute	XXXX*	
7	3rd frame	Execute	XXXX*	
8	4th frame	Execute	XXXX*	Paper-tape controlled
9	Time	Tone duration (0.5)	1	1
10	TX	Transmitter select	0 for check, then select appropriate transmitter	0 for check, then select appropriate transmitter

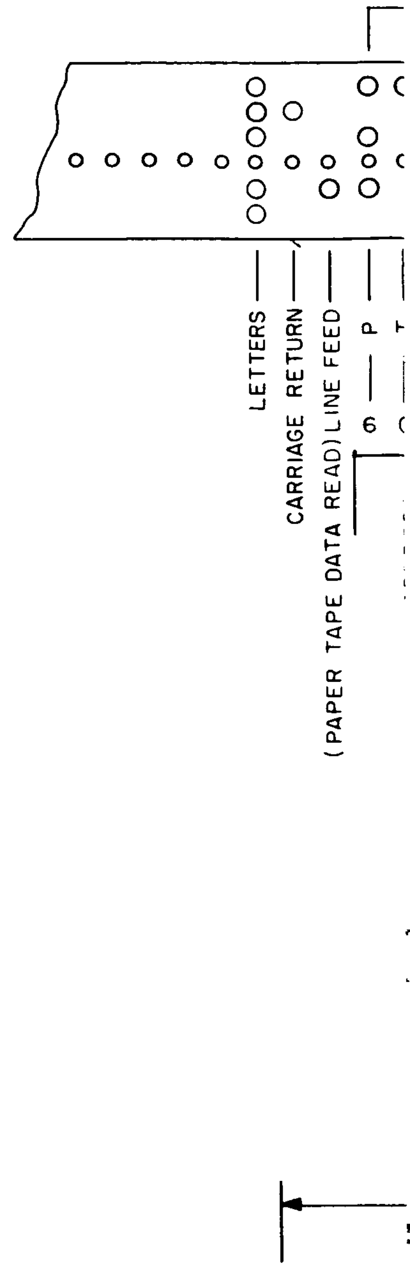
*Settings are listed in table 4-5.

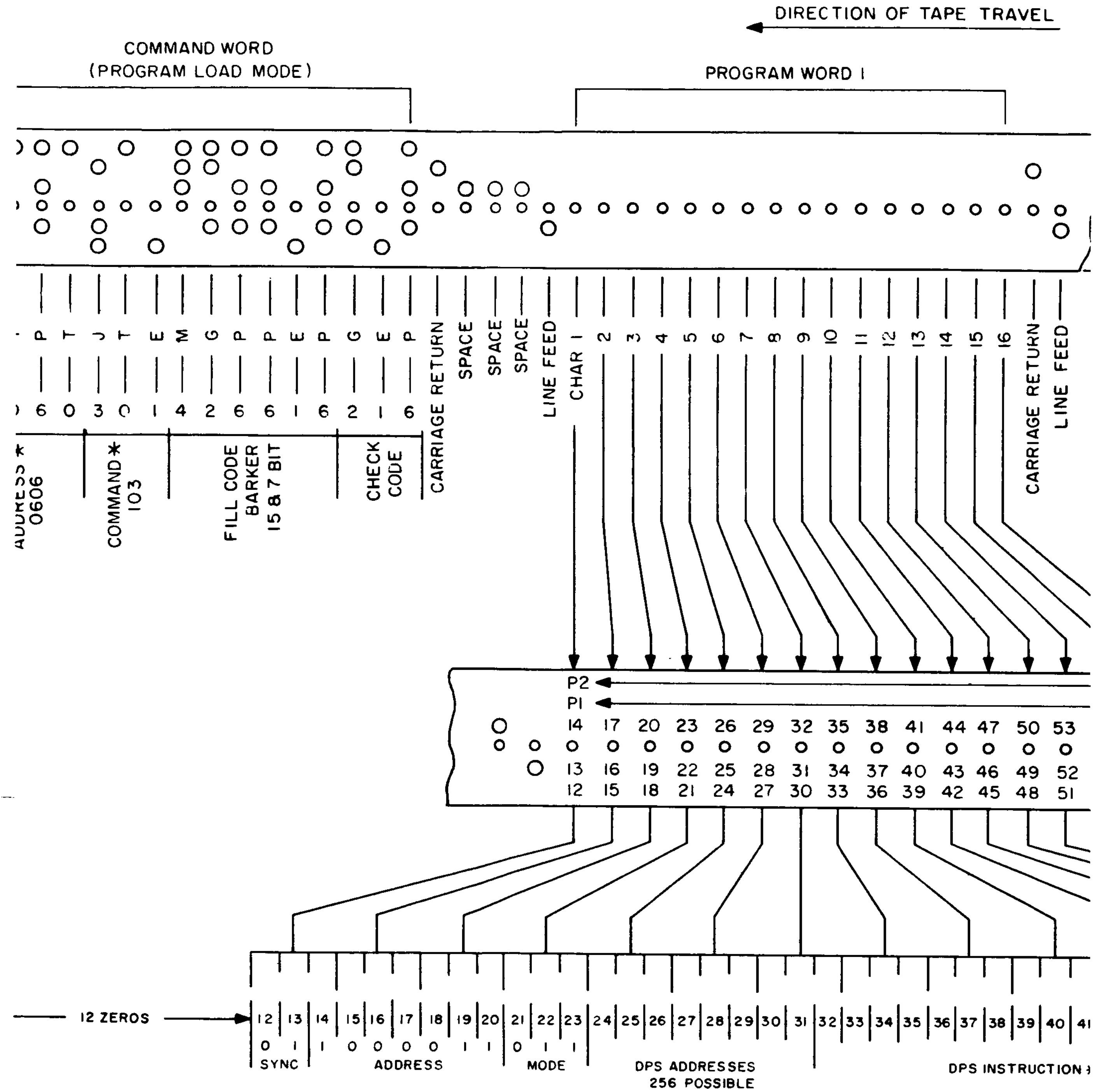


NOTES:

1. Address for SSS-A — 1000011 inserted from right to left in bit assignments.
2. Barker code fill bits — 7 bit word 1011000 and 15 bit word 111011001010000 inserted from left to right in bit assignments.
3. Command/XXX — Insert octal command from left to right in the three instruction word switches from right end. Refer to Table 2-3 for octal codes.
4. Check code in manual mode not set in instruction word switch, but will appear in nixie tube readout.

Figure 4-10. Format for Manual Mode of SSS/IMP Command Encoder for SSS-A Spacecraft Commands


LETTERS
CARRIAGE RETURN
(PAPER TAPE DATA READ) LINE FEED
6
P


DIRECTION OF TAPE TRAVEL
COMMAND WORD
(PROGRAM LOAD MODE)
PROGRAM WORD 1
P T J T E M G P P E P G E P
6 0 3 0 1 4 2 6 6 1 6 2 1 6
ADDRESS *
0606
COMMAND *
103
FILL CODE
BARKER
15 & 7 BIT
CHECK
CODE
CARRIAGE RETURN
SPACE
SPACE
SPACE
LINE FEED
CHAR 1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
CARRIAGE RETURN
LINE FEED
P2
P1
14 17 20 23 26 29 32 35 38 41 44 47 50 53
13 16 19 22 25 28 31 34 37 40 43 46 49 52
12 15 18 21 24 27 30 33 36 39 42 45 48 51
12 ZEROS
12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41
0 1 1 0 0 0 0 1 1 0 1 1
SYNC
ADDRESS
MODE
DPS ADDRESSES
256 POSSIBLE
DPS INSTRUCTION

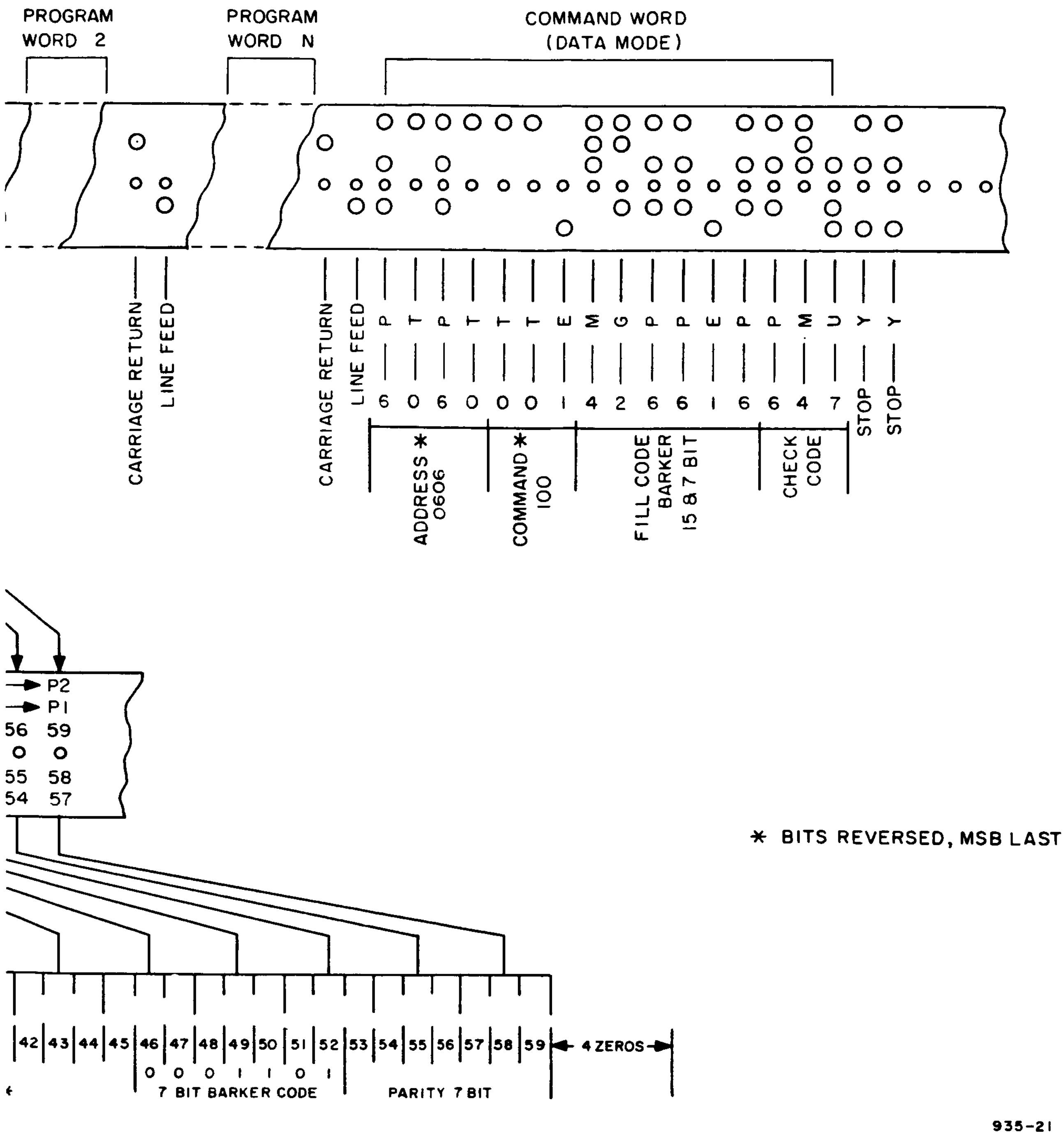
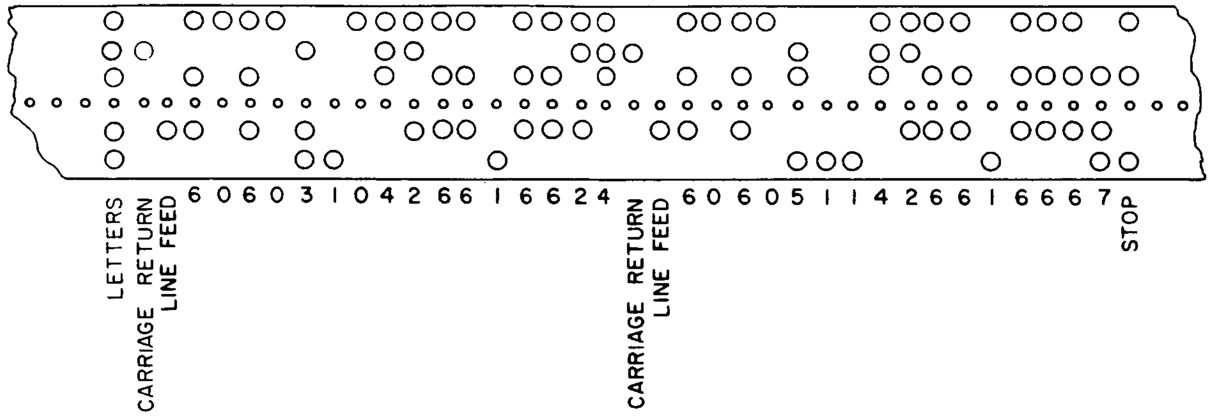


Figure 4-11. Format for Paper Tape Program Load Mode of the SSS/IMP Command Encoder for the SSS-A Spacecraft

A TWO COMMAND SEQUENCE ON PAPER TAPE

TAPE MOTION

THE TAPE AS IT APPEARS TO OPERATOR WHILE TAPE IS IN READER.



NIXIE DISPLAY OF ABOVE COMMAND	NIXIE DISPLAY OF ABOVE COMMAND
426616624013 0606	766616624115 0606

TELETYPE CHARACTER	FUNCTION	
LETTERS	INITIALIZE TELETYPE MACHINE	
CARRIAGE RETURN	INITIALIZE TELETYPE MACHINE	
SPACE	GENERATE A ONE SECOND DELAY BEFORE SENDING COMMAND (2 SPACE CHARACTERS, 2 SECONDS OF DELAY, etc.)	
LINE FEED	ALLOW COMMAND ENCODER TO ACCEPT DATA OFF PAPER TAPE.	
T	NUMERICAL CHARACTER,	0
E		1
G		2
J		3
M		4
F		5
P		6
U		7
Y	STOP COMMAND ENCODER	

ALL TELETYPE CHARACTERS USED HAVE ODD PARITY

935-22

Figure 4-12. Format for Paper Tape Command Mode of the SSS/IMP Command Encoder for the SSS-A Spacecraft

SECTION 5

NASA COMMUNICATIONS CENTER OPERATIONS

SECTION 5

NASA COMMUNICATIONS CENTER OPERATIONS

5.1 INTRODUCTION

The NASA Communications (NASCOM) network provides the ground communications support for NASA spaceflight programs. All global circuits are routed through GSFC which is the switching center for circuits used in support of spacecraft. The NASCOM global network includes all of the circuits, terminals, and switching equipments that interconnect tracking and data acquisition stations with mission centers, project control centers, computing centers, etc. NASA Communications Division operates the NASCOM network and issues the NASCOM operating procedures (NASCOP). Figure 5-1 shows the ground system circuits used during launch support and for the mission lifetime. Circuits between the San Marco launch complex and the NASCOM Madrid Switching Center will be provided by the Centro Richerche Aerospaziali (CRA).

5.2 TELETYPE COMMUNICATIONS

NASA will utilize the existing NASCOM network for all teletype communications between GSFC and supporting Spacecraft Tracking and Data Network (STDN) stations. Teletype communications and procedures for member stations of the NASCOM network will be in accordance with Appendixes B and D of the NASCOP.

5.2.1 SPECIAL TELETYPE LINKS

Teletype communications will be provided from the San Marco Range launch complex to the NASA Communications Switching Center in Madrid for launch support. Figure 5-1 illustrates the special full-period circuits to be provided for the SSS-A mission. The teletype circuit from the San Marco launch complex will be established by T-30 days and will remain operational until at least T+7 days.

5.2.2 ADDRESSING TRAFFIC

All mission-oriented traffic will be addressed to GOPS and GPHY.

5.3 VOICE COMMUNICATIONS

Two four-wire full-period voice circuits between the San Marco Range launch complex and the NASA communications switching center in Madrid will be

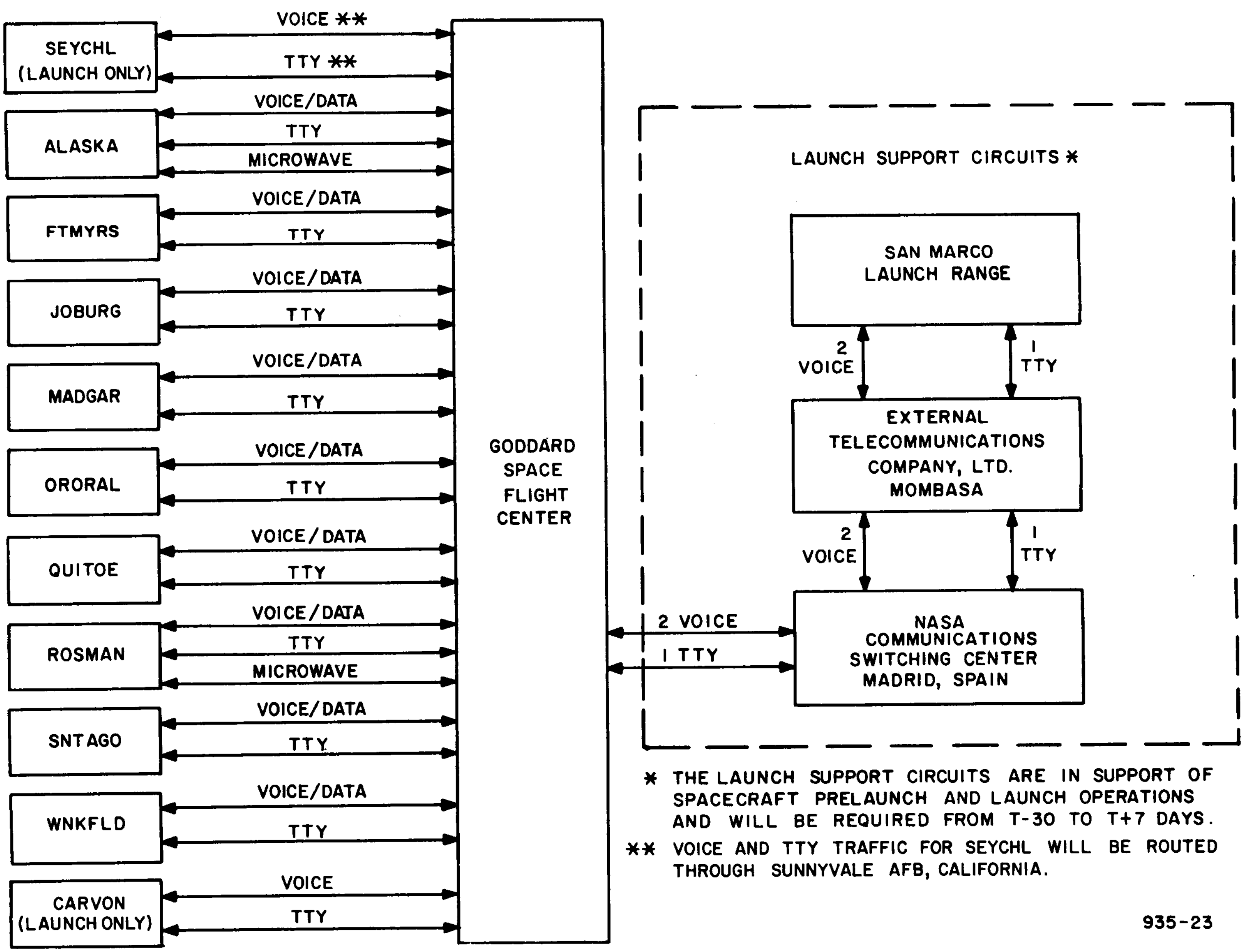


Figure 5-1. SSS-A Ground Communications Diagram

established for prelaunch, launch, and postlaunch support. These circuits will interface with the SCAMA network at the Madrid switching center and will not be terminated earlier than T+7 days.

Voice communications will be provided between GSFC and the STDN stations participating in the SSS-A mission.

Voice switching/conferencing of the voice circuits required for STDN operations will be accomplished at the GSFC SCAMA facility as requested by the Operations Control Center.

5.4 TELEMETRY DATA TRANSMISSION

PCM telemetry data (446 and 1784 bps) will be transmitted to the Multi-Satellite Operations Control Center (MSOCC) and to the Data Reduction Laboratory (DRL) via the data transmission system (DTS). Existing data modems, Model 203 or Model 205, and voice/data links will be used for this purpose. The decoded PCM telemetry data will be sent from MSOCC to the Spacecraft Integration Laboratory (SIL) via coaxial cable, as required.

ROSMAN and ALASKA will use appropriate microwave channels as a back-up means of transmitting PCM telemetry data to MSOCC and to DRL.

ROSMAN will transmit SSS-A wideband analog data to MSOCC via the microwave link. If possible, microwave channel A3 will be used for this purpose. Microwave channel A1, A2, or B2 will be used if channel A3 is not available.

During the launch phase, ORORAL will use an asynchronous Model 202 data modem to transmit redundant PCM telemetry data to MSOCC and DRL*.

5.5 NASCOM NETWORK SCHEDULING GROUP (NNSG)

The NNSG will schedule the utilization of circuitry within the NASCOM network to ensure that the necessary circuitry is available to meet mission requirements. In addition, those resources of the NASCOM network which are not initially committed to the mission will be available for use in case of an emergency.

5.6 TROUBLE REPORTING

When troubles are experienced on the NASCOM voice, data, or teletype circuits during real-time operations, they should be reported in accordance with the

*Redundant to DTS

appropriate OPSCON procedure. In the event that the OPSCON procedure cannot be followed, troubles will be reported as follows:

a. Remote sites — to the serving NASCOM switching center

b. At GSFC

(1) Voice circuits — voice control (SCAMA)

(2) Teletype circuits — teletype technical control (EXT 4925)

(3) Analog or non-digital data circuits — voice control (SCAMA)

(4) Digital data circuits — data technical control (EXT 6672)

NOTE

In the event contact cannot be made with the areas indicated above, the trouble reports will be made to the NASCOM Shift Communications Manager (EXT 6141).

All adjustments to the line or signal levels, or changes to the NASCOM circuit configuration, must be coordinated with the appropriate technical control area.

5.7 POSTPASS REPORTING

Immediately following each real-time operation, or as soon as schedules permit, MSOCC will be conferenced with the appropriate NASCOM facilities to discuss any impairments, anomalies, failures, or loss of communication. If possible the source of the problem and a solution will be identified.

SECTION 6
ORBITAL COMPUTATIONS

SECTION 6

ORBITAL COMPUTATIONS

6.1 INTRODUCTION

The GSFC Computation Division (CD) and the Trajectory Analysis and Geodynamics Division (TAGD) of the Mission and Data Operations Directorate (M&DOD) have the prime responsibility for the orbital computation activities supporting the SSS-A mission.

6.2 PREDICTIONS

Using all available interferometer data, the CD will update the spacecraft orbit and will generate station predictions, mission planning predictions, and predicted orbital data. The accuracy of all operational predictions will be ± 1 minute (time), or better.

6.2.1 STATION PREDICTIONS

Requirements for station predictions are listed in Table 6-1. Predictions for Seychelles, Mahe (SEYCHL), the San Marco Range Base Camp (SMARBC), and the Iowa State University (IOWASU) will be included in the world map/station observations books, etc., but will not be transmitted from GSFC in the usual manner.

6.2.2 MISSION PLANNING PREDICTIONS

World map/station observations books and scheduling matrix/pass summary computer printouts will cover one-week periods. Postlaunch predictions will be generated and distributed at least one week prior to the beginning of each prediction period. The distribution of mission planning predictions will be as indicated in Table 6-2.

6.2.3 ORBITAL ELEMENTS AND EQUATOR CROSSINGS

In addition to the standard distribution to the STDN stations, and other standard addressees, orbital elements and equator crossings will be sent by TTY as follows:

a. MSOCC (GPHY)

b. LaRC*

*First update of orbital elements only.

Table 6-1. Station Prediction Requirements

Station	Latitude & Meridian Crossings	Az-El Observations	Topocentric	
			$\theta_1 - \theta_2$	ENV
ALASKA	X	X	X	X
FTMYRS	X	X	X	
JOBURG	X	X	X	X
MADGAR	X	X	X	X
ORORAL	X	X	X	X
QUITOE	X	X	X	X
ROSMAN		X	X	X
SNTAGO	X	X	X	
WNKFLD	X	X	X	
NETEST		X	X	
SEYCHL*		X		
CARVON*		X	X	
SMARBC**		X		
IOWASU***		X		

*Nominal predictions only.
**Predictions for the SMARBC are for the nominal orbit and the first orbit update only.
***Predictions for IOWASU for the nominal orbit and for the first four weeks following launch only.

Table 6-2. Mission Planning Predictions Distribution

Recipient	Number of Copies	
	Nominals	Postlaunch
OPSCON	1	1
MISSOC	1	1
MSOCC	2	2
Project Office	—	2
MSM	5	1*
University of Iowa**	1	1*

*First four weeks after launch only.
**World map/station observations books, only; to be mailed weekly by MSOCC to:
Roger R. Anderson
University of Iowa

c. SSS-A Project at SMR*

6.2.4 SPECIAL PREDICTED ORBITAL DATA

The CD will provide special predicted orbital data in support of attitude control operations and experimenter quick-look analysis.

6.2.4.1 Attitude Control Orbital Data

EPHEM (ephemeris) tapes will be provided to the Attitude Determination Office (ADO) starting with the first update of the orbit after launch. The production rate, etc., for these tapes will be as follows:

Production Rate	Data Interval	Tape Duration
Weekly	1 minute	2 weeks
Every three months	8 minutes	8 months

6.2.4.2 Experimenter Quick-Look Orbital Data

Predicted ORB-3A tapes and Edit B printouts will be generated starting with the first update of the orbit after launch, using the special POGO 8/69 Model magnetic field coefficients. The ORB-3A tapes and Edit B printouts will be produced monthly and will contain one month of data. The tapes and printouts will be distributed by MSOCC to the following experimenters:

Experimenter	ORB-3A Tape	Edit B Printouts
Dr. Hoffman, GSFC	X	X
Dr. Williams, NOAA	X	X
Dr. Gurnett, University of Iowa	X	X
Dr. Cahill, University of Minnesota		X

*First update of orbital elements and equator crossings only.

6.3 EARLY-ORBIT DETERMINATION

Orbit determination during the early-orbit phase will be the overall responsibility of the CD, with support being provided by the TAGD.

Only a qualitative indication of launch vehicle performance is expected from the San Marco Range (SMR); however, an attempt will be made to compute a rough orbital solution within 5 hours after launch, as desired by the Project (not a mandatory requirement). All available interferometer and X-Y data will be used for this attempted computation, but it is expected that tracking data will not be sufficient for a spacecraft orbit determination at this point in time.

It is anticipated that there will be sufficient interferometer data available by the time of the JOBURG/MADGAR orbit 1/2 pass for the first update of the orbit approximately 9 to 13 hours after launch.

6.4 DEFINITIVE ORBITAL DATA

The TAGD is responsible for providing definitive orbital data. The best accuracy which can be achieved with a resonable orbit determination effort will be provided. The Project radial component accuracy requirement for definitive orbits is ±5 km at 2 earth radii geocentric and ±150 km at apogee; however, this cannot be guaranteed at all times. The TAGD will provide orbital uncertainty estimates with the definitive orbit data.

6.4.1 DEFINITIVE ORBIT TAPES

The TAGD will produce definitive orbit tapes for four-week arcs, with six-hour overlap periods. The special POGO 8/69 Model magnetic field coefficients will be used for this purpose. The ADO will receive an EPHEM tape and an ORB-3A tape, both with 1 minute data intervals, within four weeks following the corresponding tracking period. The ADO and IPD will be jointly responsible for adding the definitive attitude solution to the definitive orbit tape.

6.4.2 REFINED WORLD MAPS

Refined world maps corresponding to the definitive orbit tapes will be provided within four weeks after the corresponding tracking period. Distribution of the refined world maps will be made according to Table 6-3.

Table 6-3. Distribution of Refined World Maps

Recipient	Number of Copies
MISSOC	1 (original)
Project Office	2
Dr. Hoffman, GSFC	1
Dr. Williams, NOAA	1
Dr. Konradi, MSC	1
Dr. Maynard, GSFC	1
Dr. Gurnett, University of Iowa	1
Dr. Cahill, University of Minnesota	1

6.5 SPECIAL ORBITAL ANALYSIS

Special orbital analysis studies for the SSS-A mission are the responsibility of Mr. George M. Marechek of the Trajectory and Dynamics Branch. An orbital lifetime/perturbation study will be conducted starting with the first update of the orbit after launch. Additional studies will be conducted upon special request.

SECTION 7
DATA REDUCTION

SECTION 7

DATA REDUCTION

7.1 INTRODUCTION

The GSFC Information Processing Division (IPD) is responsible for processing the SSS-A telemetry data recorded by the Spaceflight Tracking and Data Network (STDN) stations. The data-processing operations consist of an evaluation of the station tapes, analog-to-digital conversion of the data, and shipment of experiment tapes. Analysis of the data is the responsibility of the individual experimenters.

7.2 DATA PROCESSING REQUIREMENTS

The IPD will be required to process SSS-A analog tapes, telemetered from the spacecraft, to produce digital experimenter tapes for further processing and analysis by the experimenters. Four weeks will be allowed for shipping a group of tapes containing one week of telemetered data to GSFC. Two weeks will be allowed for processing the data on the STARS phase II system and 2 weeks for the UNIVAC 1108 ground data processing system. A definitive attitude/orbit tape will be prepared and sent to the experimenters every 4 weeks, beginning with the 12th week after launch.

A 16-mm microfilm reel of tabulated data and plotted information from the fixed format subcommutator words will be supplied to the Project Office. Each film will contain 1 week of telemetered data (to the nearest orbit), and be prepared within 8 weeks after the data were recorded. Long term trend plots will be supplied every 4 weeks, beginning 12 weeks after launch.

Wideband analog data will be recorded, evaluated, and sent to Dr. Gurnett of the University of Iowa within 6 weeks of acquisition.

The launch support will last for a period of 2 weeks. The data will be recorded during the 2-week period on a 24-hour-a-day basis. During the first 4 days, the telemetry data will be computer processed on a 24-hour-a-day basis. For the remainder of the launch support, the data will be processed only during the day.

An experimenter quick-look will be performed for 2 passes per week. This operation will take 4 to 6 hours. The quick-look experimenter tapes will be sent to Dr. Hoffman, Code 646, within 5 days of recording. DRL quick-looks will be performed for all SSS-A flight program loading.

7.3 ANALOG TAPE SHIPPING INSTRUCTIONS

Analog tapes recorded at STDN stations will be sent to the following address:

NASA Goddard Space Flight Center
Building 16
Greenbelt Road
Greenbelt, Maryland 20771 U.S.A.

M/F Data Processing Branch, Code 564
Analog Tape Library

7.4 DATA PROCESSING FLOW

The data telemetered by SSS-A are received in analog tape form by the Information Processing Division, GSFC. The Data Processing Branch is responsible for receipt of the analog tapes containing the telemetered data, tape evaluation, accounting, analog-to-digital (A/D) conversion, editing, quality control, and transmitting the converted data tapes to the Telemetry Computation Branch. The Telemetry Computation Branch is responsible for data identification of the edited tapes, attitude computation, filming, quality control, and shipping of the resultant experimenter data tapes.

7.4.1 SIGNAL PROCESSING

Each week, the Data Processing Branch analog tape library receives station logs and approximately 100 SSS-A analog tapes from the STDN stations (see Figure 7-1). Approximately 10 percent of the analog tapes are sent to Tape Evaluation, where checks are made to evaluate track assignments, recording techniques, and proper frequency and modulation. The pass summaries are processed through the Telemetry Data Accounting Office (TDAO), where data from the station logs are manually prepared as 100 analog cards (a station-by-station listing) and are compared with the cumulative telemetry reports. The listing and cards are sent to the NASA Production Control Center (PCC) for preparation of the digitization schedule. When scheduled, the analog tapes and cards are delivered to the proper STARS II data processor where the data on the tapes undergo A/D conversion, editing, and quality control processing. The STARS II data processor outputs 100 time correction cards, 100 editing tapes, 100 accounting cards, and a STARS II quality listing. The tapes and cards are then sent to temporary storage in the Telemetry Computation Branch. They will be

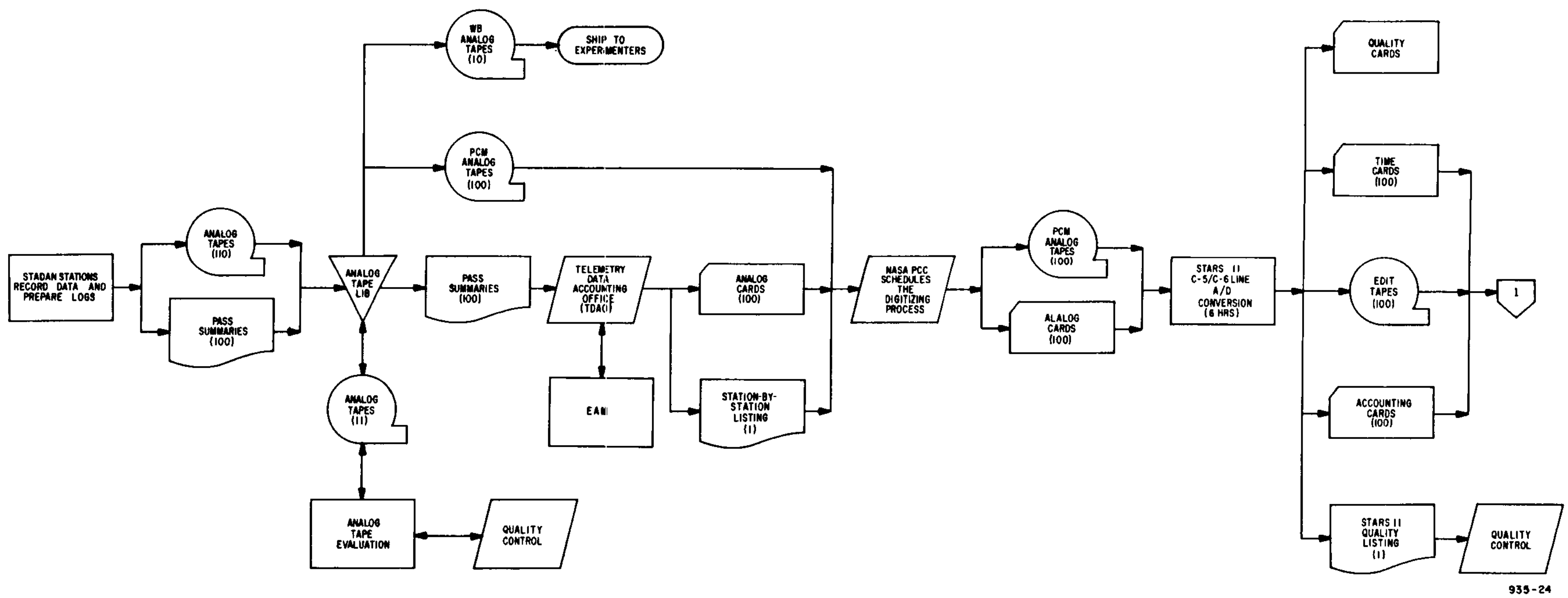


Figure 7-1. Data Processing Diagram for the Data Processing Branch

further processed on the UNIVAC 1108 when scheduled. The STARS II quality listing is sent to Quality Control where it is used to evaluate the signal processing.

7.4.2 COMPUTER PROCESSING

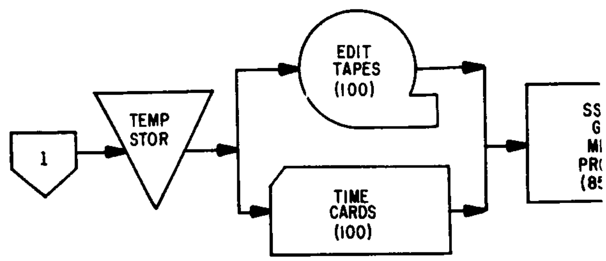
The ground data processing system (GDPS) for the SSS-A is a group of UNIVAC 1108 computer programs designed to process telemetry data (see Figure 7-2). The software provided for the GDPS includes a production processing program, a definitive attitude/orbit module, a merge program, and a quality determination program. The software will be used with the IPD UNIVAC 1108 multiprocessing system and the Stromberg-Datagraphix 4060 high speed microfilm recorder (SD 4060).

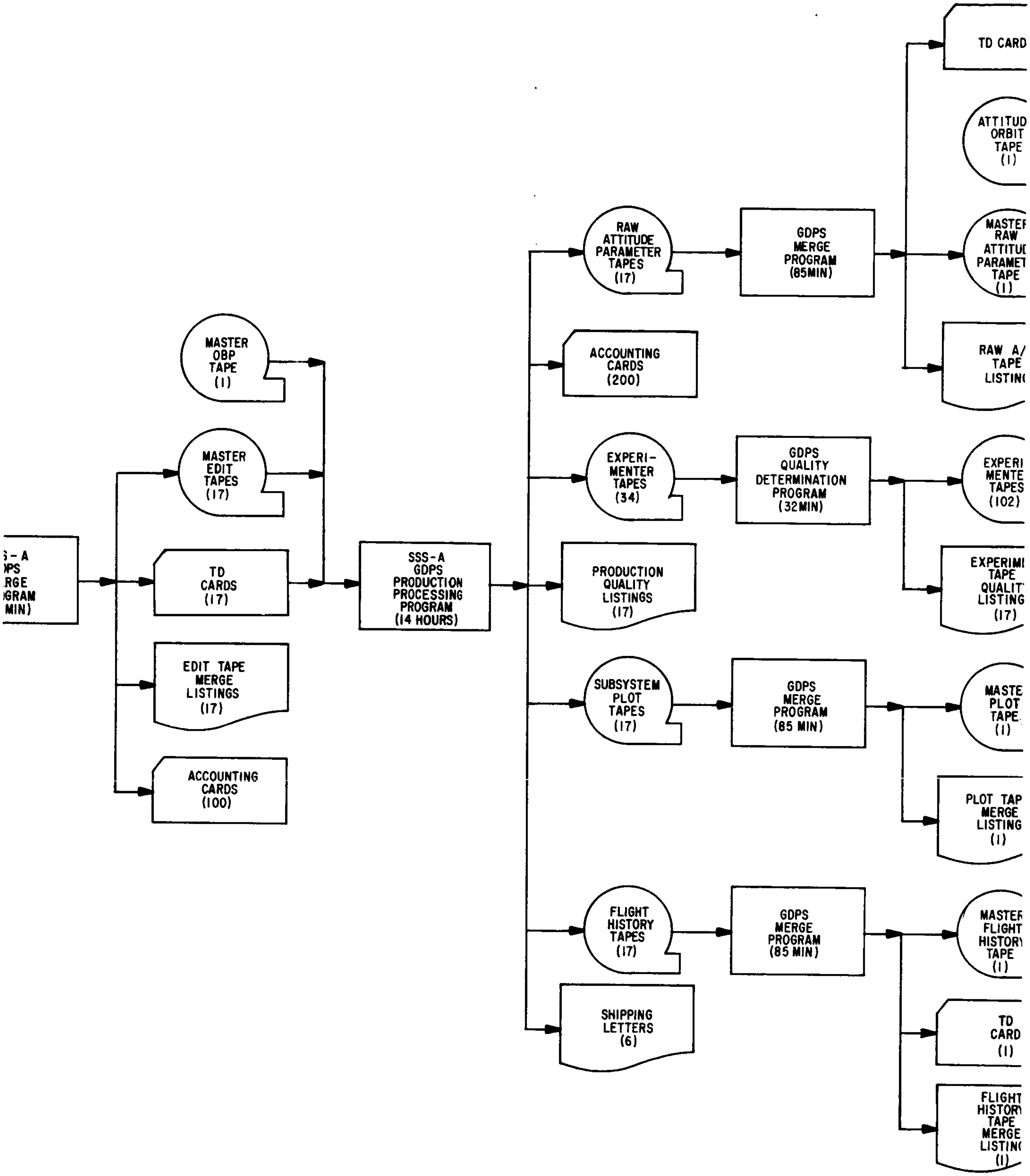
All production edit tapes produced by the CDC-3200 will be collected by the Tape Staging and Storage Facility and scheduled for merging by the Data Analysis Group. The edit tapes will be grouped by orbit and merged into a master edit tape using the SSS-A merge program. The edit tapes will be kept until the master edit tape has been validated, then they will be released for degaussing.

The production processing phase uses the production processing program of the GDPS along with supporting modules to generate two experimenter tapes. A master edit tape is used as input for production runs. The production runs are scheduled and submitted by the Data Analysis Group with one master edit tape (one orbit) at a time. After validation, the master edit tape is sent to storage.

The Data Analysis Group merges the raw attitude parameter tapes generated by the production program into a master attitude parameter tape with the SSS-A merge program. An attitude/orbit tape is provided by the Attitude Determination Office which contains attitude data for a number of orbits. A copy of the attitude/orbit tape made with the IBM 1401 is used by the definitive attitude/orbit module. The original attitude/orbit tape is sent to storage and the copied attitude/orbit tape is retained as needed.

The definitive attitude/orbit module is used every 2 weeks to produce a definitive/orbit tape from the master raw attitude parameter tape and the attitude/orbit tape. The definitive attitude/orbit tape is then used by the SSS-A quality determination program to produce six copies for the experimenters. After validation of the tapes, the master raw attitude parameter tape and one definitive attitude/orbit tape are sent to storage. The raw attitude parameter tapes are released for degaussing.


1
TEMP
STOR
EDIT
TAPES
(100)
TIME
CARDS
(100)



TD CARD
ATTITUD
ORBIT
TAPE
(1)
MASTEF
RAW
ATTITUI
PARAMET
TAPE
(1)
RAW ATTITUDE PARAMETER TAPES (17)
GDPS MERGE PROGRAM (85MIN)
ACCOUNTING CARDS (200)
RAW A/
TAPE
LISTIN
MASTER OBP TAPE (1)
MASTER EDIT TAPES (17)
EXPERI-MENTER TAPES (34)
GDPS QUALITY DETERMINATION PROGRAM (32MIN)
EXPERI
MENTE
TAPES
(102)
TD CARDS (17)
SSS-A GDPS PRODUCTION PROCESSING PROGRAM (14 HOURS)
PRODUCTION QUALITY LISTINGS (17)
EXPERIMI
TAPE
QUALIT
LISTING
(17)
EDIT TAPE MERGE LISTINGS (17)
SUBSYSTEM PLOT TAPES (17)
GDPS MERGE PROGRAM (85 MIN)
MASTE
PLOT
TAPE
(1)
ACCOUNTING CARDS (100)
PLOT TAP
MERGE
LISTING
(1)
FLIGHT HISTORY TAPES (17)
GDPS MERGE PROGRAM (85 MIN)
MASTEF
FLIGHT
HISTOR
TAPE
(1)
SHIPPING LETTERS (6)
TD CARD (1)
FLIGHT
HISTOR
TAPE
MERGE
LISTIN
(1)

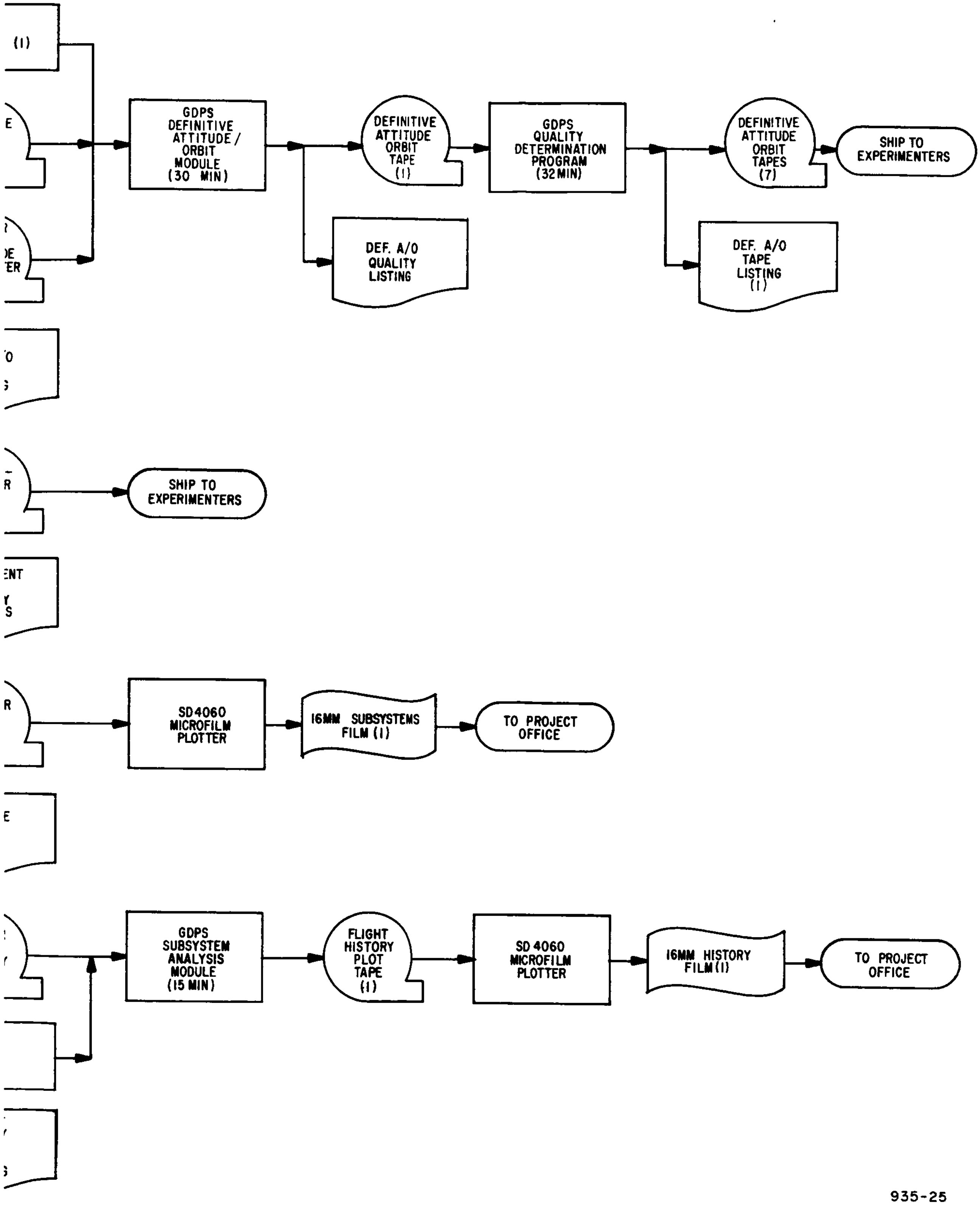


Figure 7-2. Computer Processing Diagram for the Telemetry Computation Branch

The subsystem plot tapes each covering one orbit, produced in the production phase are merged together on a weekly basis using the SSS-A merge program. The Data Analysis Group then uses the merged master plot tape to produce a 16 mm cartridge using the SD 4060. The input tapes to the SSS-A merge program are released for degaussing after the film has been checked. The master plot tape is sent to storage after it has been used for filming. Three additional copies of all films are made, with the original going to the SSS-A Project Support Office. The copies are given to the Data Processing Specialist, the World Data Center, and to Archives.

The flight history tapes, produced by the subsystem analysis module, are collected and merged to create a master flight history tape using the SSS-A merge program. The master flight history tape is then processed by the subsystem analysis module of the production program to produce a flight history plot tape. This plot tape is then used by the Data Analysis Group to generate long term trend plots on the SD 4060 plotter. The flight history tapes and the master flight history plot tapes are released for degaussing after the plots have been checked, and the master flight history tape is sent to storage. Three copies of the film are made and distributed as outlined above.

The quality determination phase uses the SSS-A quality determination program to check the data on the two experimenter tapes that were produced using the telemetry identification module of the production program. This program also generates and quality checks the five additional copies of the experimenter tapes for distribution.

7.5 DATA DISTRIBUTION

The experimenter tapes and definitive attitude/orbit tapes, which are returned to GSFC for reuse, are sent to the experimenters at the following addresses:

Dr. L. J. Cahill, Jr.
Space Science Center
University of Minnesota
Minneapolis, Minnesota 55455

Dr. D. A. Gurnett
Department of Physics and Astronomy
University of Iowa
Iowa City, Iowa 52240

Dr. R. A. Hoffman
NASA-Goddard Space Flight Center
Code 646
Greenbelt, Maryland 20771

Dr. Andrei Konradi
Code TG
NASA/MSC
Houston, Texas 77058

Dr. N. C. Maynard
NASA-Goddard Space Flight Center
Code 645
Greenbelt, Maryland 20771

Dr. D. J. Williams
Space Disturbance Laboratory
NOAA
Boulder, Colorado 80302

7.6 DATA REDUCTION LABORATORY

The data reduction laboratory (DRL) is used by the SSS-A Project to examine the telemetry data processed by the ground data processing system. The DRL equipment consists of three Sanders 720 communication consoles and three IDIIOM vector data display consoles that are connected to a UNIVAC 1108 multiprocessor computer system. A description of the different steps required to process the telemetry data is given in the following paragraphs and is shown in Figure 7-3.

The pre-DRL processor program first decommutates the experiment tape and produces a DRL input tape on which each sensor value is tagged with time and sensor number.

The DRL program which is used to process the DRL input tape is made up of two parts; syntax and dialog. The syntax consists of a group of GORTRAN statements which describe the location of the user's data, the computations to be applied to the data, and the names to be assigned to the computed values. The dialog is a question-and-answer sequence which describes the type and format of the user's output.

After the equipment has been turned on and the DRL run started, the user communicates with the computer through a Sanders 720 terminal. He uses the terminal to retrieve programs from the DRL library and to group those he wishes to execute. The user then indicates which tape he wishes processed and for which time period. When the execution is complete, the data are displayed on the IDIIOM.

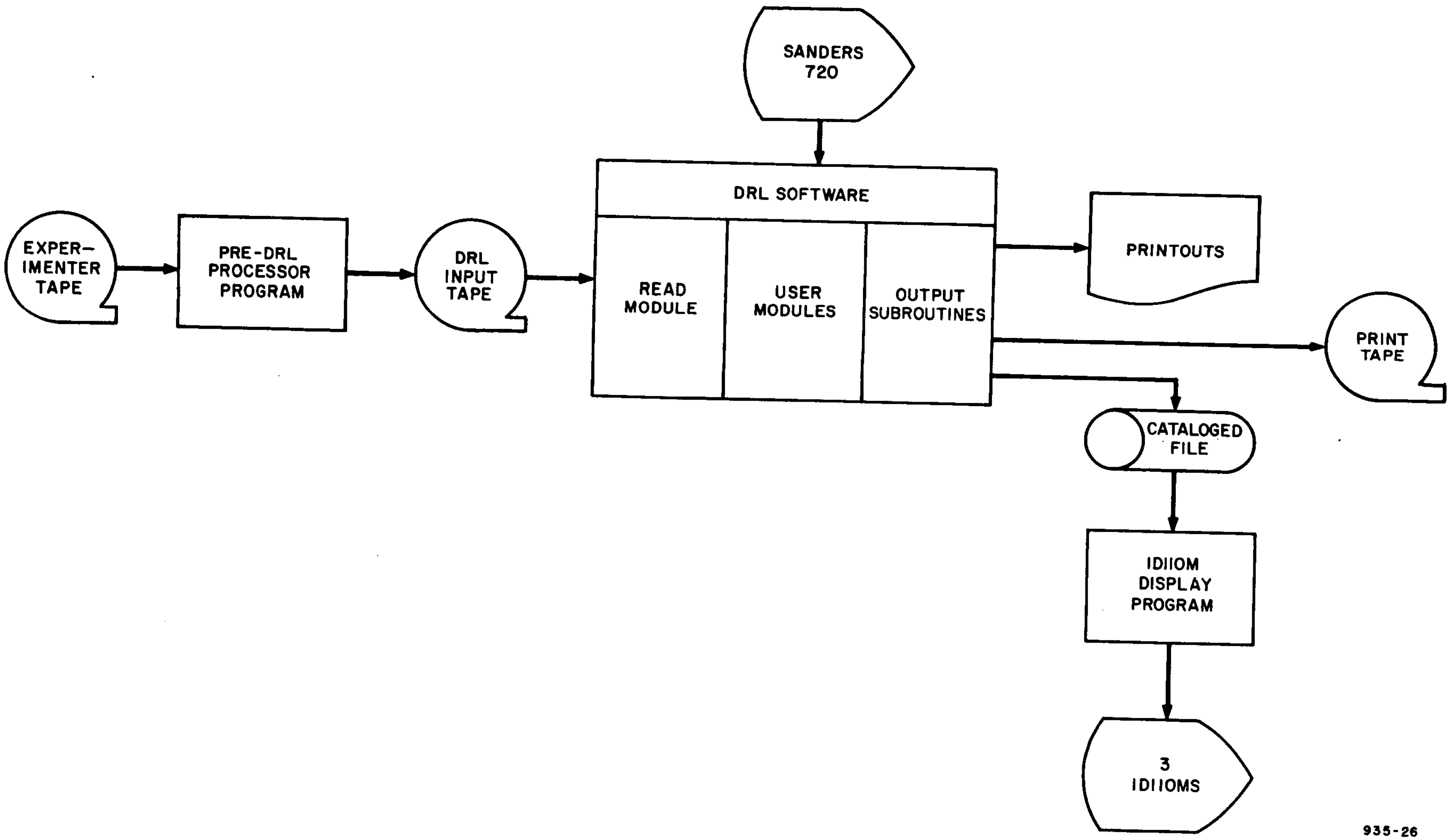


Figure 7-3. DRL Data Flow

7.7 PROGRAM WRITE AND CHECKOUT FACILITY (PWCF)

The program write and checkout facility is used to write and checkout flight programs for the on-board SSS-A computer. A CDC 3200 computer and an IDIIOM graphic display, along with a set of software programs, make up the facility.

The Project Support Office supplies the Data Processing Engineer (DPE) with the information that is needed to write a flight program for the SSS-A. The DPE gives the information to the PWCF personnel so that they may write an SSS-A assembler flight program and check it out by simulation. The PWCF returns to the DPE a program listing, a flow chart, a command paper tape, and any other printouts that might be needed. After checking the program, the DPE then gives it to the Project Office. The PWCF also generates a new master OBP tape for input to the ground data processing system (GDPS) on the UNIVAC 1108.

A data flow diagram of the PWCF is shown in Figure 7-4. The DPS assembler is used to assemble the SSS-A flight program and to produce a DPS program tape and a command tape along with a program listing. The DPS program tape is used with several other PWCF programs to obtain all of the necessary outputs. The primary output is the command paper tape, which is produced by the paper tape punch and verify program. The command paper tape is then read by the paper tape format verify program to produce a listing of the commands and any error codes. The flow-chart generator program is used to make a flow chart of the SSS-A program on the line printer.

The SSS-A flight program can be checked out with the DPS simulator program. Data for the simulation are produced by the input data generator program; the output format generator program formats the data according to the expected formats. The DPS simulator program uses the SSS-A flight program (DPS program tape) and the test data (OFG tape) to produce a simulator tape and a printout of the telemetry frames, program memory, buffer memory, and a trace of instruction execution. The DPS simulator also provides for the control and modification of the simulation from the IDIIOM. The simulator tape can be used by the PCM software and hardware to produce an analog tape, which can be read by the SSS-A processing program on the CDC 3200 phase II system.

After the SSS-A program has been checked out and accepted, the OBP tape generation program is used to generate a new master OBP tape to be used by the GDPS.

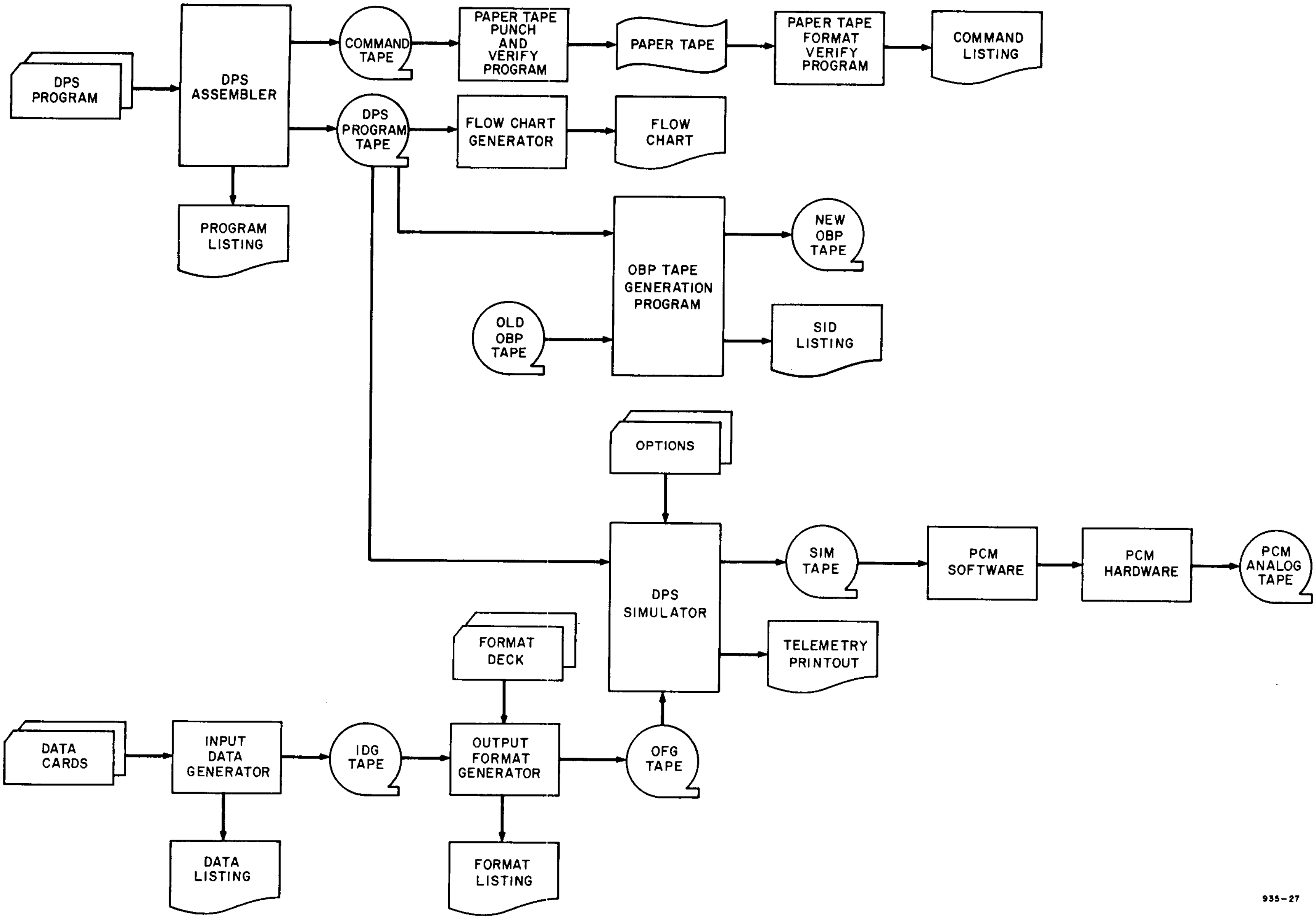


Figure 7-4. PWCF Data Flow

SECTION 8
COMPOSITE COUNTDOWN

SECTION 8
COMPOSITE COUNTDOWN

8.1 COMPOSITE COUNTDOWN SCHEDULE

The composite countdown schedule is referenced to the nominal lift-off time and lists only those periods in the SSS-A countdown that require action by the GSFC ground support elements.

COMPOSITE COUNTDOWN SCHEDULE

COUNTDOWN	ACTION	RESPONSIBILITY
T-15 Days	Forward notification of nominal launch date and time to NORAD and other standard addressees	OPSCON
T-10 Days	Forward notification of nominal launch date and time to all participating facilities	OPSCON
T-7 Days	Forward nominal predictions to all participating stations	COMPUT
T-6 Hours	Forward notification of launch status to NORAD	OPSCON
T-3-1/2 Hours	Conduct verification of station readiness and their understanding of mission support requirements	NOCC
T-160 Minutes	Sent T-150 minute launch alert	OPSCON
T-150 Minutes	Establish Mission Director/Launch Status and Vehicle Coordination Circuits	MCC
T-130 Minutes	Establish Mission Operations Circuit	OPSCON
T-120 Minutes to T-30 Minutes	Begin station and MSOCC data circuit checkout using simulation tape	Prime stations and MSOCC
T-70 Minutes	Send T-60 minute launch alert	OPSCON
T-60 Minutes	Submit vehicle and spacecraft status report to OPSCON	SMR
T-50 Minutes to T-30 Minutes	Conduct final prelaunch check of station PCM command encoder and data link to MSOCC	ORORAL/MSOCC

COUNTDOWN	ACTION	RESPONSIBILITY
T-30 Minutes	Place Launch Status Circuit on OPSCON speaker system	OPSCON
T-30 Minutes	Place telephone call to the Satellite Test Center (Sunnyvale, California) for the purpose of voice communications with SEYCHL	OPSCON
T-30 Minutes	Patch simulator data to input of DTS and 202 data modem	ORORAL
T-15 Minutes	Forward spacecraft transmitting frequency and all pertinent prelaunch information to OPSCON via SCAMA and TTY	SMR
T-15 Minutes	Forward pertinent prelaunch information to all participating stations	OPSCON
T-0 Minutes	Forward notification of lift-off to OPSCON. Exact time of lift-off and other relevant launch information, such as vehicle staging events, will be forwarded to OPSCON as soon as available	SMR
T-0 Minutes	Forward pertinent launch and postlaunch information to all participating facilities	OPSCON
T+15 Minutes	Transmit spacecraft doppler data to OPSCON via TTY	SMR
T+15 Minutes	Place Mission Operations Circuit on OPSCON speaker system	OPSCON
T+15 Minutes	Terminate Vehicle Coordination Circuit and place SMR and LaRC on monitor status on the Mission Operations Circuit	MCC/OPSCON
T+15 Minutes	Patch output of 136.83-MHz telemetry receiver demodulator into inputs of DTS and backup 202 data modem	ORORAL

LIST OF ABBREVIATIONS AND ACRONYMS

LIST OF ABBREVIATIONS AND ACRONYMS

A/D	analog-to-digital
ADC	Aerospace Defense Command
ADO	Attitude Determination Office
AGC	automatic gain control
ALASKA	Fairbanks, Alaska, STDN station
AM	amplitude modulation
amp	ampere
ampl	amplifier
AOS	acquisition of signal
ASCS	attitude and spin control system
ASM	accelerated subcommutator mode
avg	average
az	azimuth
BCDT	binary-coded decimal time
bep	bit error probability
bps	bits per second
BW	bandwidth
CCL	closed conference loop
CCTV	closed circuit television
cmd	command
cont	continued
CW	continuous wave
CARVON	Carnarvon, Australia, STDN station
D/A	digital-to-analog
db	decibel
dbm	decibel referenced to 1 milliwatt
deg	degree
demod	demodulator
DOB	Data Operations Branch
DPS	data processing system
DRL	Data Reduction Laboratory
DTG	date-time group
DTR	diversity telemetry receiver
DTS	data transmission system

el	elevation
ERP	effective radiated power
ev	electron volt
exp	experiment
FM	frequency modulation
FSK	frequency shift keying
FTMYRS	Fort Myers, Florida, STDN station
FTS	Federal Telephone System
GCC	ground communications coordinator
GCEN	TTY address for Network Operations Control Center
GDCS	TTY address for Data Operations Branch
GDPS	ground data processing system
GNET	TTY address for GSFC Network Control
GNST	TTY address for GSFC Network Support Team
GOPS	TTY address for GSFC Operations Control Center
GRTS	Goddard real-time system
GSFC	Goddard Space Flight Center
HVPS	high voltage power supply
Hz	Hertz (cycles per second)
ID	identification
IPD	Information Processing Division
ips	inches per second
IRIG	Inter-Range Instrumentation Group
JOBURG	Johannesburg, South Africa, STDN station
kbps	kilobits per second
kev	kiloelectron volt
kHz	kilohertz
km	kilometer
kw	kilowatt
LaRC	Langley Research Center
lb	pound
LHC	left-hand circular
LOS	loss of signal
m	meter
man	manual
M&DOD	Mission and Data Operations Directorate

MADGAR	Tananarive, Malagasy Republic, STDN station
max	maximum
MCC	Mission Control Center
Mev	million electron volts
M/F	mark for
MFRT	multifunctional receiver, telemetry
MHz	megahertz
min	minimum, minute
MISSOC	Mission Scheduling Operations Center
MITS	Mobile Italian Telemetry Station
mm	millimeter
mod	modulation
MOSM	Mission Operations Systems Manager
ms	millisecond
MSM	Mission Support Manager
MSOCC	Multi-Satellite Operations Control Center
mw	milliwatt
NA	not applicable
NASA	National Aeronautics and Space Administration
NASCOM	NASA Communications Network
NASCOP	NASA Communications Operating Procedure
ND	Networks Directorate
Ni-Cd	nickel-cadmium
NOCC	Network Operations Control Center
NOM	Network Operations Manager
NORAD	North American Air Defense Command
NOSP	Network Operations Support Plan
NRZ	nonreturn-to-zero
NRZ-C	nonreturn-to-zero change
NSM	Network Support Manager
NSP	NASA Support Plan
NST	Network Support Team
NTTF	Network Test and Training Facility
OA	optical aspect
OC	Operations Controller
OCD	Operating Control Directive

OPSCON	Operations Control Center
ORORAL	Canberra, Australia, STDN station
PAM	pulse amplitude modulation
PAO	Public Affairs Office
PASSUM	pass summary message
PCM	pulse code mudulation
pgm	program
pk	peak
PM	phase modulation
POCC	Project Operations Control Center
pps	pulses per second
PWCF	Program Write and Checkout Facility
pwr	power
QUITOE	Quito, Ecuador, STDN station
Re	earth radius
ref	reference
rcvr	receiver
RF	radio frequency
RFI	radio frequency interference
RHC	right-hand circular
ROSMAN	Rosman, North Carolina, STDN station
rpm	revolutions per minute
SAO	Smithsonian Astronomical Observatory
SCADS	scanning celestial attitude determination system
SCAMA	switching, conferencing, and monitoring arrangement
SCO	subcarrier oscillator
SDTC	serial decimal time code
sec	second
SEYCHL	Seychelles, Mahe Island
SIL	Spacecraft Integration Laboratory
SMR	San Marco Range
SNR	signal-to-noise ratio
SNTAGO	Santiago, Chile, STDN station
SOE	sequence of events
SOP	Standard Operating Procedures
SSS	Small Scientific Satellite

STDN	Spaceflight Tracking and Data Network
SUBCOM	subcommutator
TAPEX	tape exercise
TC	test conductor
TCG	time code generation
TLM	telemetry
TTY	teletypewriter
TX	transmitter
UHF	ultra-high frequency
VCO	voltage-controlled oscillator
VHF	very-high frequency
w	watts
WNKFLD	Winkfield, England, STDN station

APPENDIX A
SSS-A PREDICTED SIGNAL MARGINS

APPENDIX A
SSS-A PREDICTED SIGNAL MARGINS

A.1 INTRODUCTION

This appendix contains tables and graphs which present an estimate of the received signal strength for each spacecraft frequency link requiring support and an analysis of the calculations to determine if the estimated signal levels will permit specified data quality. Unless otherwise stated, the calculations are based on the mission orbit; however, the graphs accompanying the calculations allow prediction of signal levels at various slant ranges.

The parameters used in performing the calculations are tabulated for reference purposes. The values of the parameters are given with as many significant figures as are available; however, the results of the calculations are rounded off to three significant figures or the nearest whole unit. This simplifies the presentation without appreciably affecting the conclusion. The tables and their associated graphs will be updated only to reflect information that significantly changes these conclusions.

Where applicable, the number in parentheses opposite each parameter refers to the source material listed in paragraph A. 9, References.

The mission orbit parameters in paragraph A.2 are not current.

A.2 MISSION ORBIT PARAMETERS

a. Apogee . . . . 31,251 km (ref 4)

b. Perigee . . . . 222 km (ref 4)

c. Inclination . . . . 2.909 deg (ref 4)

d. Anomalistic period . . . . . . 545.46 min (ref 3)

e. Spin rate . . . . 4 rpm ± 10% (ref 4)

f. Spin axis orientation . . . . in-orbital plane (ref 4)

A.3 VHF LOW-POWER TELEMETRY TRANSMITTER (0.5 WATT)

a. Carrier frequency . . . . . . 136.830 MHz (ref 1)

b. Carrier modulation

(1) Type . . . . PCM (split-phase)/PM (ref 1)

(2) Modulation factor . . . . 1.16 radians, (67^{o}) pk (ref 4)

(3) Baseband . . . . 446 bps (ref 1)

(4) Spectrum bandwidth (assigned) . 3.0 kHz (ref 2)

c. Total transmitter power . . . . . +27 dbm (0.5 watt) (ref 1)

d. Carrier power drop, (PCM/PM) . . -8 db (ref 3)

e. Total sideband power . . . . . -1.0 db (ref 3)

f. Radiating antenna characteristics

(1) Type . . . . canted turnstile (ref 1)

(2) Polarization . . . . circular/linear (ref 1)

NOTE

The antenna polarization is right-hand circular along the forward spin axis, linear near the equator, and left-hand circular along the aft spin axis.

(3) Maximum gain . . . . +2 db (ref 4)

(4) Passive element losses . . . . -1 db (ref 4)

(5) Expected losses and antenna pattern null depths (ref 4)

Receiving System	Antenna Pattern Null Depths	Cross-Polarization Losses
Minitrack	-6 db ± 2 db	-4 ± 3 db
Phase-lock	-6 db ± 2 db	-3 ± 3 db
Diversity	-6 db ± 2 db	0 db

A.4 VHF HIGH-POWER TELEMETRY TRANSMITTER (3 WATTS)

a. Carrier frequency . . . . 137.950 MHz (ref 1)

b. Analog mode (ref 1)

(1) Carrier modulation . . . . . PM

(2) Baseband and modulation factors

Signal	Baseband	Modulation Factor (deg)	Modulation Factor (radian, rms)
S1	150 Hz to 10 kHz	27.5	0.480
S2	16.6-kHz ref carrier	4.75	0.083
S3*	25-kHz subcarrier, amplitude modulated by 30 Hz to 300 Hz	8.42	0.147
S4*	33.3-kHz subcarrier, amplitude modulated by 30 Hz to 3 kHz	25.73	0.449

(3) Total transmitter power . . +35 dbm (3.0 watts) (ref 1)

(4) Carrier power drop . . . . -1 db (ref 3)

(5) Sideband power (ref 3)

(a) S1 . . . . -10 db

(b) S2 . . . . -26 db

(c) S3 . . . . -21 db

(d) S4 . . . . -11 db

(6) Spectrum bandwidth (assigned) . . . . 90 kHz (ref 2)

c. PCM mode (backup mode)

(1) Carrier modulation . . . . . PM (ref 1)

(2) Baseband . . . . 446 bps (ref 1)

(3) Spectrum bandwidth (assigned) . . . . 3.0 kHz (ref 2)

(4) Total transmitter power . . +35 dbm (3.0 watts) (ref 1)

(5) Carrier power drop . . . . -8 db (ref 3)

(6) Total sideband power . . . . -1.0 db (ref 3)

(7) Modulation factor . . . . 1.16 radians (67°) pk (ref 4)

*The 25-kHz and the 33.3-kHz subcarriers are suppressed.

d. CW mode

(1) Carrier modulation . . . . . none (ref 3)

(2) Spectrum bandwidth (assigned) . . . . 3 kHz (ref 3)

(3) Total transmitter power . . . +35 dbm (3.0 watts) (ref 3)

e. Radiating antenna characteristics — Uses the same turnstile antenna as the low-power transmitter (para A.3 f)

A.5 VHF COMMAND MODE

a. Carrier frequency . . . . 148.980 MHz (ref 1)

b. Carrier modulation (ref 3)

(1) Type . . . . AM

(2) Modulation factor 80%

c. Primary command mode . . . . . PCM/FSK-AM/AM (ref 1)

(1) Word length . . . . 64 bits

(2) Bit rate . . . . 128 bps

(3) FSK subcarrier

(a) ZERO . . . . 9000 Hz

(b) ONE . . . . 9640 Hz

d. Backup command mode . . . . . tone-sequential (ref 1)

(1) Address code 1203

(2) Execute codes 1003
1006
1010

e. Receiver threshold (tone) . . . . . -117 dbm (ref 1)

f. Receiver threshold (PCM) . . . . . -116 dbm (ref 1)

g. Receiving antenna characteristics — Uses the same antenna as the low-power transmitter (para A.3 f.)

(1) Type . . . . canted turnstile (ref 1)

(2) Polarization . . . . circular/linear (ref 1)

(3) Maximum antenna gain . . . +2 db (ref 4)

(4) Passive element losses . . . -1 db (ref 4)

(5) Expected antenna pattern null depth . . . . -6 db ± 2 db (ref 4)

(6) Cross-polarization losses . . . -3 db ± 3 db (ref 3)

A.6 PERTINENT PARAMETERS

a. Receiver IF bandwidth (ref 3)

(1) Analog . . . . 300 kHz

(2) PCM . . . . 30 kHz

b. Demodulator bandwidth (ref 3)

(1) 446 bps PCM data . . . . . . 1.5 kHz

(2) Analog data . . . . 50 kHz

c. Phase-lock-loop bandwidth . . . . 30 Hz (ref 3)

d. Spectral noise density (136—138-MHz band) . . . . 169.4 dbm (+5, -1 db)/Hz (ref 3)

e. Gain correction factors for the 136-MHz band telemetry antennas using the 12-meter parabolic antenna (19 db gain) as a reference. (ref 3)

(1) 9-yagi antenna . . . . 0 db

(2) 16-yagi antenna . . . . +2 db

(3) SATAN antenna . . . . +3 db

(4) 26-meter parabolic antenna . . +7 db

f. Effective radiated power (ERP) correction factors for the 148-MHz band command systems using the 9-yagi array with the Collins 242 (200 w) transmitter as a reference. (ref 3)

(1) Dual yagi/Collins 242 (200 w) . . . . +1 db

(2) Disc-on-rod/ITA-120H (2.5 kw) . . . . +14 db

(3) SATAN/Hughes HC-300 (2.5 kw) . . . . +24 db

(4) SATAN/GE4BT91A1 (5.0 kw) . . . . +27 db

A.7 SYSTEM THRESHOLDS

a. Minitrack . . . . -135 dbm in a 10-kHz bandwidth in the ambiguity channel (ref 3)

b. Phase-lock acquisition level . . . . SNR of +6 db in a bandwidth equal to twice the loop bandwidth (ref 3)

c. PCM bep level . . . . SNR of +9 db in a bandwidth equal to twice the bit rate for 10^{-5} bit error probability (ref 3)

d. Analog (50-kHz bandwidth)

Signal	Video Bandwidth	Required Subcarrier SNR
S1	10 kHz	-7 db
S2	20 Hz	-34 db
S3	300 Hz	-22 db
S4	3 kHz	-12 db

NOTE: SNR values are referenced to SSS project data handling equipment. The required SNR is stated for 50-kHz demodulator bandwidth.

e. Spacecraft command receiver threshold (ref 1)

(1) PCM . . . . -116 dbm

(2) Tone . . . . -117 dbm

A.8 SUPPLEMENTARY INFORMATION

a. Slant ranges (ref 3)

(1) Maximum slant range, 10-degree elevation . . . . . 35,994 km

(2) Maximum slant range, 45-degree elevation . . . . 32,848 km

(3) Minimum slant range . . . . . 222 km

b. Maximum doppler . . . . ±4282 Hz (ref 3)

c. Maximum rate-of-change of doppler . . . . 209 Hz/sec (ref 3)

A.9 REFERENCES

Ref 1 — Support Instrumentation Requirements Documents, Project: S^3-A, dated April 1, 1969, revised November 20, 1970

Ref 2 — Frequency Management Office, Code 515

Ref 3 — Operations Assurance Section, Code 863

Ref 4 — SSS Project Office, Code 724

Ref 5 — NASA Support Plan, SSS-A dated May 20, 1970

Table A-1
Received Signal Strength, Minitrack Interferometer System, Ambiguity Antennas (SSS-A, 136.830 MHz — PCM/PM)

Parameter	Mean Values 32,848 km (max range)	Mean Values 222 km (min range)	Assumed Standard Deviation
Total transmitter power	+27 dbm	+27 dbm	—
Spacecraft antenna maximum gain	+2 db	+2 db	—
Spacecraft antenna passive element losses	-1 db	-1 db	—
Propagation losses	-166 db	-122 db	± 1 db
Ground antenna maximum gain	+3 db	+6 db	—
Ground antenna passive element losses	-1 db	-1 db	—
Total received signal power	-136 dbm	-89 dbm	—
Power loss (10-kHz IF BW for Minitrack)	0 db	0 db	—
Maximum received signal power	-136 dbm	-89 dbm	—
Expected null depth	-6 db	-6 db	± 2 db
Cross-polarization losses	-4 db	-4 db	± 3 db
Expected null level	-146 dbm	-99 dbm	—
Signal required for ambiguity resolution	-135 dbm	-135 dbm	—
Signal margin, optimum system	-11 db	+36 db	—
System operating margin	-3 db	-3 db	± 3 db
Adjusted signal margin	-14 db	+33 db	± 5 db

NOTE:

For the high-power transmitter (137.950 MHz), add +8 db to the adjusted signal margin for the PCM or CW mode; and add +7 db for the analog mode.

CONCLUSION:

Minitrack support capability will be marginal above the slant ranges listed below:

Mode	45°	90°
Low-power transmitter		
446 bps data	6,800 km	9,700 km
High-power transmitter		
PCM mode	17,300 km	24,400 km
Analog	15,400 km	21,800 km
CW mode	17,300 km	24,400 km

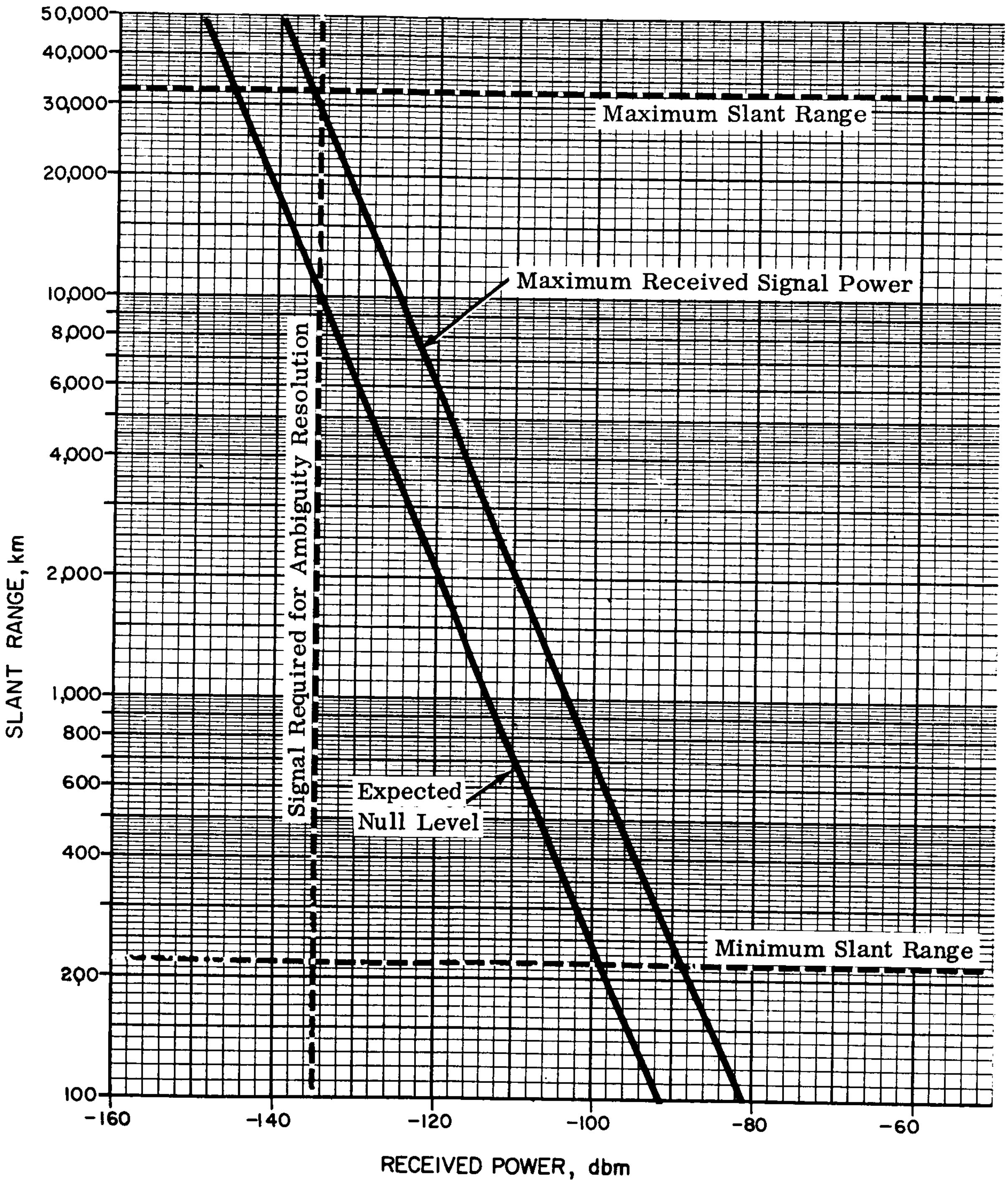


Figure A-1. Received Signal Strength, Minitrack Interferometer System, Ambiguity Antennas (SSS-A, 136.830 MHz — PCM/PM)

Table A-2
Received Signal Strength, 12-Meter Parabolic Antenna, Phase-Lock-Loop Requirements
(SSS-A, 136.830 MHz — PCM/PM)

Parameter	Mean Values		Assumed Standard Deviation
	35,994 km (max range)	222 km (min range)	
Total transmitter power	+27 dbm	+27 dbm	—
Spacecraft antenna maximum gain	+2 db	+2 db	—
Spacecraft antenna passive element losses	-1 db	-1 db	—
Propagation losses	-166 db	-122 db	± 1 db
Ground antenna maximum gain	+19 db	+19 db	—
Ground antenna passive element losses	-1 db	-1 db	—
Total received signal power	-120 dbm	-76 dbm	—
Correction factor (carrier power drop)	-8 db	-8 db	—
Maximum received carrier power	-128 dbm	-84 dbm	—
Expected null depth	-6 db	-6 db	± 2 db
Cross-polarization losses	-3 db	-3 db	± 3 db
Expected null level	-137 dbm	-93 dbm	—
Received noise power, 30-Hz loop BW	-152 dbm	-152 dbm	+5, -1 db
Received SNR	+15 db	+59 db	—
SNR required to acquire phase-lock	+6 db	+6 db	—
Signal margin, optimum system	+9 db	+53 db	—
System operating margin	-3 db	-3 db	± 3 db
Adjusted signal margin	+6 db	+50 db	+5, -7 db

NOTE:

The adjusted signal margins listed below are for the high-power transmitter (137.950 MHz) of SSS-A spacecraft operation.

High-Power Transmitter	Adjusted Signal Margin	
	Max Range	Min Range
PCM mode	+14 db	+58 db
Analog mode	+21 db	+65 db

CONCLUSION:

Sufficient signal margin is available to expect acquisition and maintenance of carrier phase-lock at all expected slant ranges.

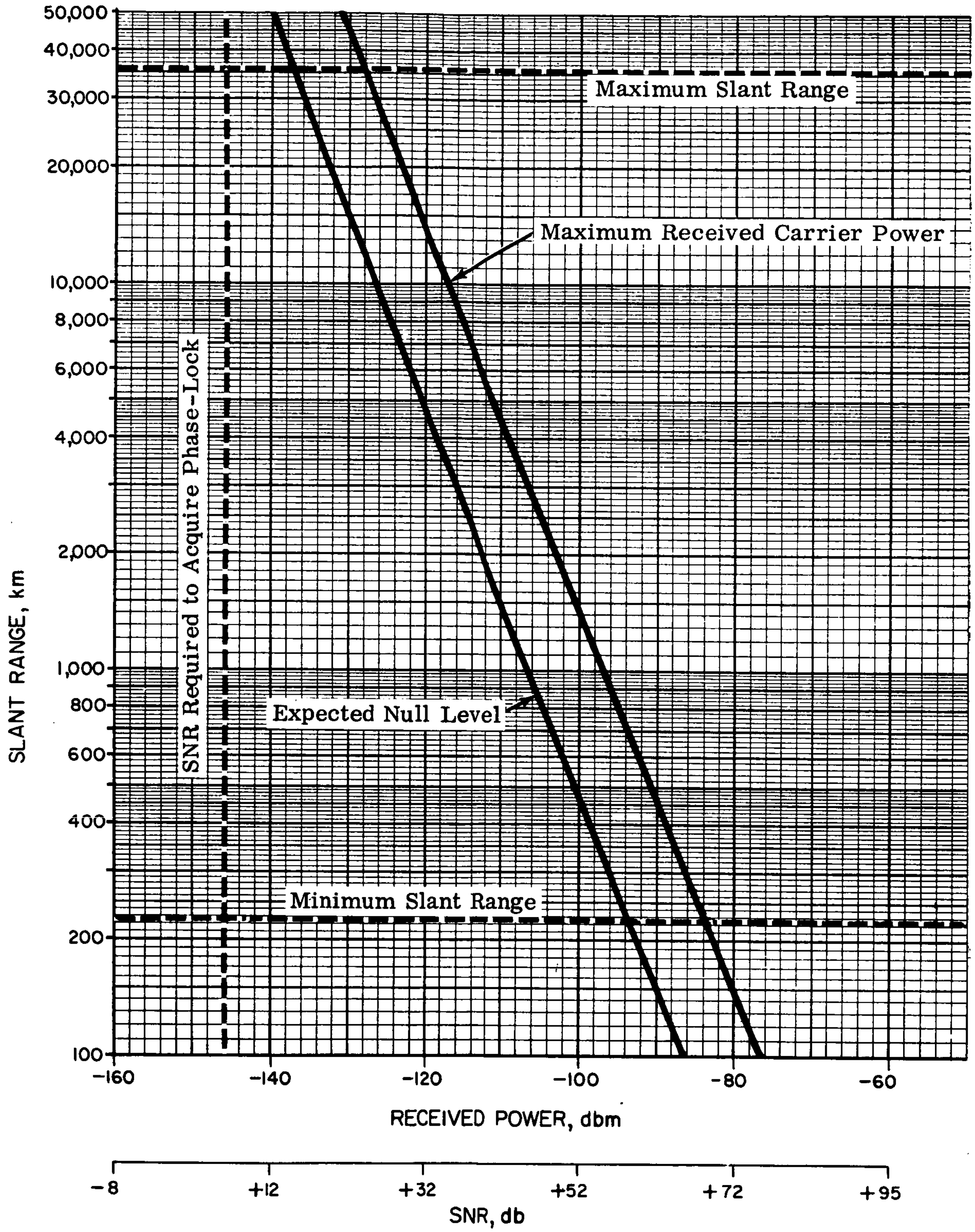


Figure A-2. Received Signal Strength, 12-Meter Parabolic Antenna, Phase-Lock-Loop Requirements (SSS-A, 136.830 MHz — PCM/PM)

Table A-3
Received Signal Strength, 12-Meter Parabolic Antenna, Polarization Diversity Reception (SSS-A, 136.830 MHz — PCM/PM)

Parameter	Mean Values 35,994 km (max range)	Mean Values 222 km (min range)	Assumed Standard Deviation
Total transmitter power	+27 dbm	+27 dbm	—
Spacecraft antenna maximum gain	+2 db	+2 dbm	—
Spacecraft antenna passive element losses	-1 db	-1 db	—
Propagation losses	-166 db	-122 db	± 1 db
Receiving antenna gain	+19 db	+19 db	—
Passive element losses	-1 db	-1 db	—
Total received signal power	-120 dbm	-76 dbm	—
Correction factor (total sideband power)	-1 db	-1 db	—
Maximum received sideband power	-121 dbm	-77 dbm	—
Expected null depth	-6 db	-6 db	± 2 db
Expected null level	-127 dbm	-83 dbm	—
Received noise power, 1.5-kHz demodulator bandwidth	-138 dbm	-138 dbm	+5, -1 db
Received SNR	+11 db	+55 db	—
SNR required for 10^{-5} bep	+7 db	+7 db	—
Signal margin, optimum system	+4 db	+48 db	—
System operating margin	-3 db	-3 db	± 3 db
Adjusted signal margin	+1 db	+45 db	+4, -7 db

NOTE:

For the high-power transmitter (137.950 MHz), add +8 db to the adjusted signal margin for the PCM mode.

CONCLUSION:

The SATAN receive antenna is recommended for the low-power transmitter at slant ranges beyond 37,000 km; however sufficient signal margin is available to expect data acquisition at the slant ranges shown.

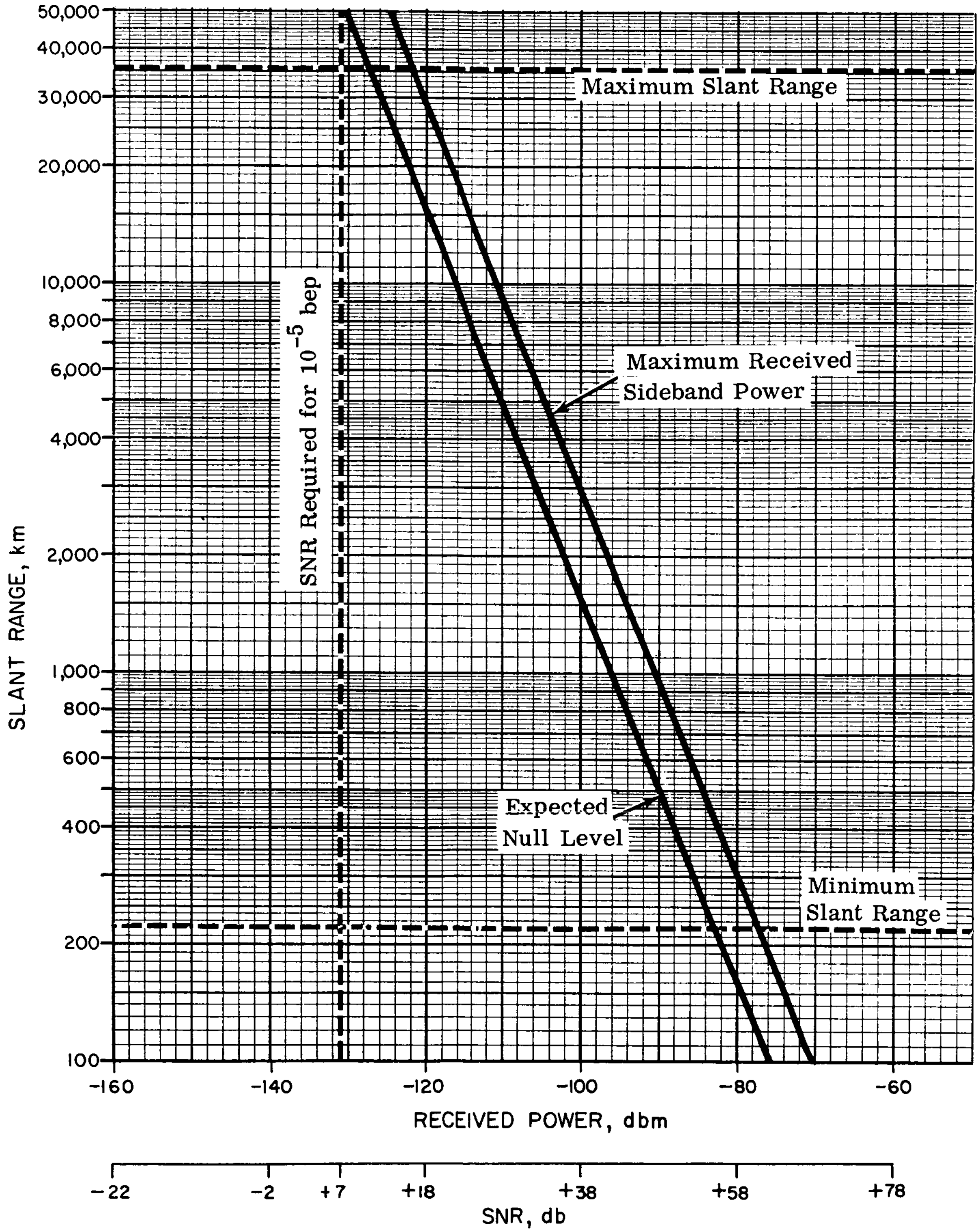


Figure A-3. Received Signal Strength, 12-Meter Parabolic Antenna, Polarization Diversity Reception (SSS-A, 136.830 MHz — PCM/PM)

Table A-4
Received Signal Strength, 12-Meter Parabolic Antenna, Polarization Diversity Reception
(SSS-A, 137.950 MHz — Analog Mode)

Parameter	Mean Values		Assumed Standard Deviation
	35,994 km (max range)	222 km (min range)	
Total transmitter power (high-power)	+35 dbm	+35 dbm	—
Spacecraft antenna maximum gain	+2 db	+2 db	—
Spacecraft antenna passive element losses	-1 db	-1 db	—
Propagation losses	-166 db	-122 db	± 1 db
Ground antenna maximum gain	+19 db	+19 db	—
Ground antenna passive element losses	-1 db	-1 db	—
Total received signal power	-112 dbm	-68 dbm	—
Correction factor (S1 sideband power)	-10 db	-10 db	—
Maximum received sideband power	-122 dbm	-78 dbm	—
Expected null depth	-6 db	-6 db	± 2 db
Expected null level	-128 dbm	-84 dbm	—
Received noise power, (50-kHz demodulator noise bandwidth)	-122 dbm	-122 dbm	+5, -1 db
Received SNR, Optimum System	-6 db	+38 db	—
System operating margin	-3 db	-3 db	± 3 db
Adjusted signal margin for Network equipment	-9 db	+35 db	+4, -6 db

NOTES:

1. The above adjusted signal margin for Network equipment is for S1 data received and recorded on station tape.

   The adjusted signal margin expected for Network equipment for each analog signal is as follows:

Signal	Sideband Correction Factor	Adjusted Signal Margin	
		Max Range	Min Range
S1	-10 db	-9 db	+35 db
S2	-26 db	-26 db	+19 db
S3	-21 db	-21 db	+24 db
S4	-11 db	-11 db	+34 db

2. For SSS Project data handling equipment, the SNR threshold for each analog signal is as follows:

Signal	SNR Required for Data Decommutation	Adjusted SNR Threshold	
		Max Range	Min Range
S1	-7 db	-2 db	+42 db
S2	-34 db	+9 db	+53 db
S3	-22 db	+2 db	+46 db
S4	-12 db	+2 db	+46 db

CONCLUSION:

Based on SSS Project data handling equipment, marginal data are expected at slant ranges beyond 27,390 km. The signal received by the Network equipment will have a very low SNR for a large portion of the orbit, making any on-site quality checks extremely difficult.

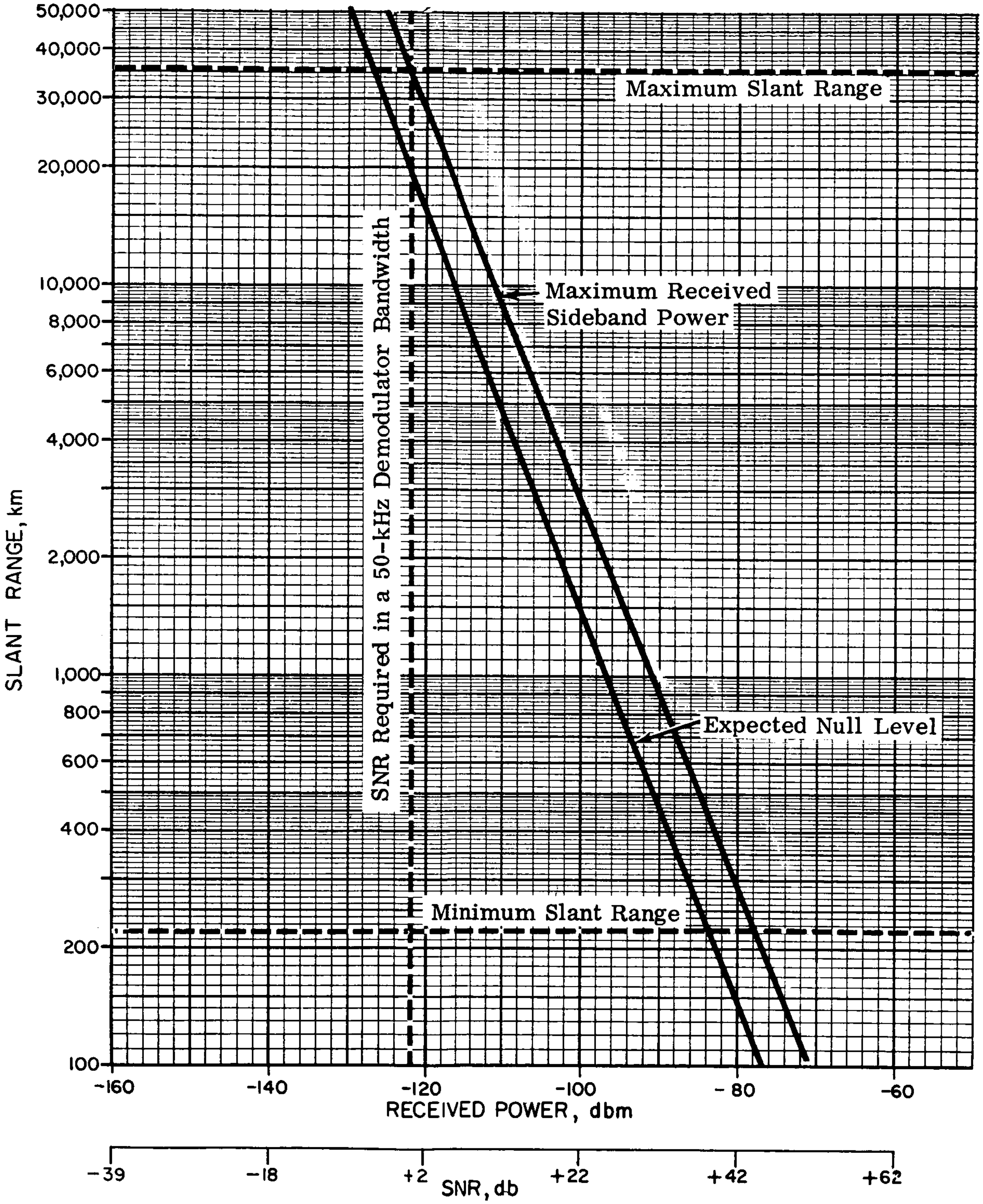


Figure A-4. Received Signal Strength, 12-Meter Parabolic Antenna, Polarization Diversity Reception (SSS-A, 137.950 MHz — Analog Mode)

Table A-5
Received Signal Strength, Command System, 9-Yagi/Collins-242 Command System
(SSS-A, 148.980 MHz — PCM/FSK — AM/AM)

Parameter	Mean Values		Assumed Standard Deviation
	35,994 km (max range)	222 km (min range)	
Total effective radiated power	+63 dbm	+63 dbm	—
Propagation losses	-166 db	-123 db	± 1 db
Spacecraft receiving antenna gain	+2 db	+2 db	—
Spacecraft antenna passive element losses	-1 db	-1 db	—
Total received signal power	-102 dbm	-59 db	—
Correction factor	0 db	0 db	—
Maximum received signal power	-102 dbm	-59 db	—
Expected null depth	-6 db	-6 db	± 2 db
Cross-polarization losses	-3 db	-3 db	± 3 db
Expected null level	-111 dbm	-68 dbm	—
Command receiver threshold (PCM)	-116 dbm	-116 dbm	—
Signal margin, optimum system	+5 db	+48 db	—
System operating margin	-3 db	-3 db	± 3 db
Adjusted signal margin	+2 db	+45 db	± 5 db

NOTE:

For the tone-sequential command system (threshold = -117 dbm) add +1 db to the above signal margins.

CONCLUSION:

No threshold problems are anticipated with the 9-yagi/Collins-242 command system when sending commands in the PCM or tone-sequential modes.

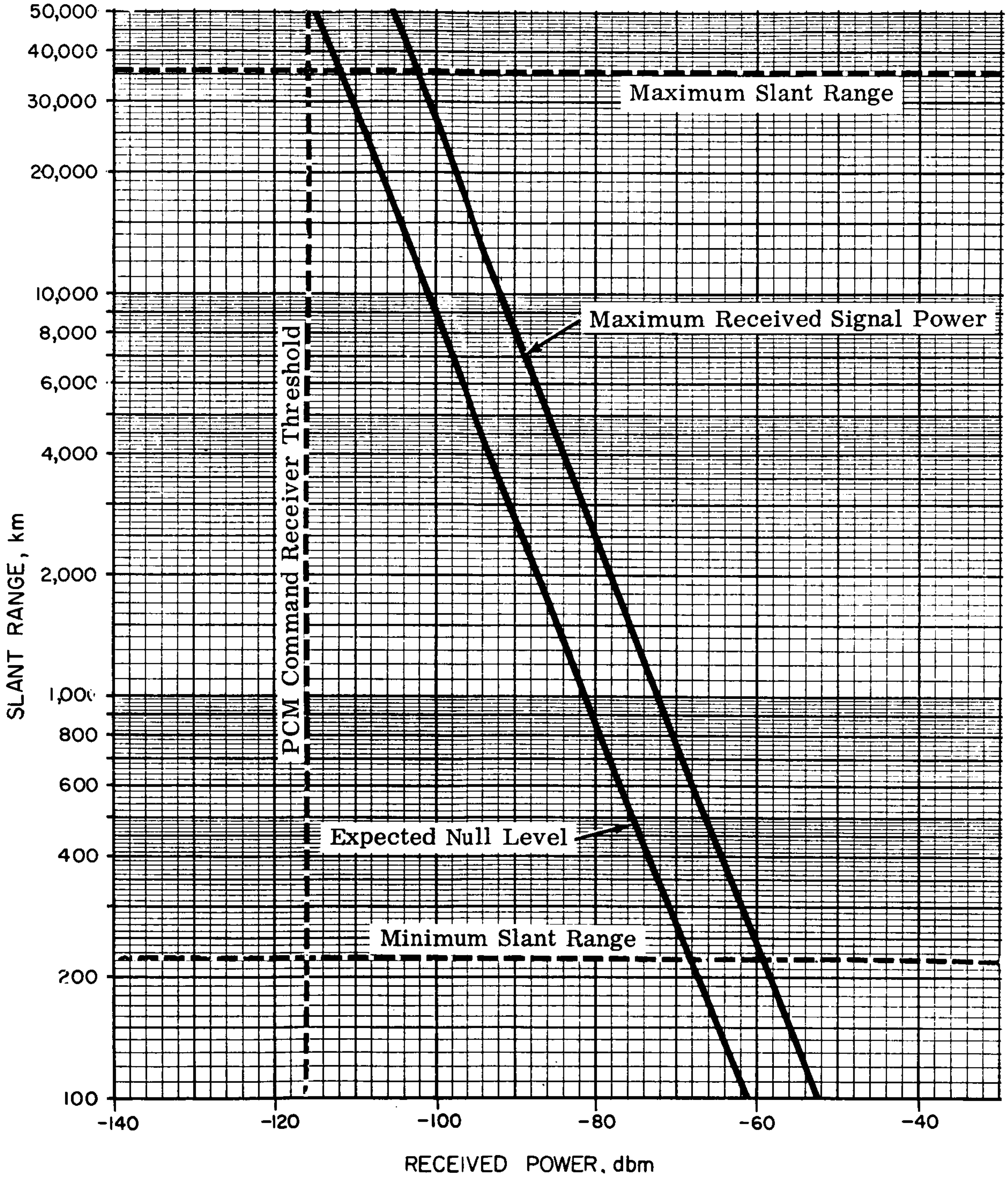


Figure A-5. Received Signal Strength, Command System, 9-Yagi/Collins-242 Command System (SSS-A, 148.980 MHz — PCM/FSK-AM/AM)

APPENDIX B
SSS-A POTENTIAL FREQUENCY CONFLICTS

APPENDIX B

SSS-A POTENTIAL FREQUENCY CONFLICTS

B.1 INTRODUCTION

This appendix identifies the spacecraft which are potential sources of radio frequency interference (RFI) to the SSS-A mission.

B.2 POTENTIAL 136.830-MHZ AND 137.950-MHZ CONFLICTS

Tables B-1 and B-2 list the spacecraft, both present and future, that are potential sources of RFI with the 136.830-MHz and 137.950-MHz telemetry frequencies. The following units of measurements are used in these tables:

a. Frequency . . . . MHz

b. Emission/Power . . . . type/watts

c. Modulation . . . . type

d. Incl (inclination) . . . . degrees

e. Apogee . . . . kilometers

f. Perigee . . . . kilometers

B.3 POTENTIAL 148.980-MHZ CONFLICTS

Table B-3 lists the spacecraft, both present and future, that are potential sources of RFI with the 148.980-MHz command frequency. The following units of measurement are used in the table:

a. Frequency . . . . MHz

b. Conflicting tones or codes . . . . Hz

c. Incl (inclination) . . . . degrees

d. Apogee . . . . kilometers

e. Perigee . . . . kilometers

In addition, the System column identifies the command mode of the spacecraft as follows:

PCM . . . . pulse code modulation

T . . . . tone

Table B-1. Potential 136.830-MHz Conflicts

Spacecraft Mission	Launch Date	Frequency	Assigned Emission/ Power	Modulation	Incl	Apogee	Perigee	Remarks
DODGE	7/1/67	136.800	40F9/10	PAM/FM/PM	6.4	33,666	33,256	A
IMP-J	Sked 2Q73	136.800	30F9/8	FM/PM or PCM/PM	28.5	250,000	200,000	B
SSS-A	Sked 3Q71	136.830	3F9/0.5	PCM/PM	2.9	31,251	222	C
TOPO-A	4/8/70	136.840	10F9/0.1	PAM/FM/PM	99.8	1,091	1,087	C, D
TETR-2	11/8/68	136.860	3F9/0.1	PAM/FM/PM	32.9	822	365	C
OAR-901	Sked 3Q71	136.860	90F9/2	PCM/FM	92	1,875	140	B
RAE-B	Sked 2Q73	136.860	10F9/6	PCM/PM	28	384,000	384,000	C, E

REMARKS:

A. Normal mode of operation is one data transmission of ten minutes duration per hour as programmed by earth station telecommand. Network ceased support of DODGE in October 1970; at that time spacecraft was operational.

B. Transmits only on earth station command or interrogation.

C. Continuous radiation is normal mode of operation, but signal can be commanded on/off as required.

D. TOPO-A signal can be commanded on/off only by Army Topographic Command facilities. Network ceased support of TOPO-A in October 1970; at that time spacecraft was operational.

E. RAE-B planned selenocentric orbit elements include 50° inclination, 1100 km apogee and perigee.

Table B-2. Potential 137.950-MHz Conflicts

Spacecraft Mission	Launch Date	Frequency	Assigned Emission/ Power	Modulation	Incl	Apogee	Perigee	Remarks
ANS-A	Sked 3Q74	137.890	A0/10F9/0.25 or 30F9/2	CW or PCM/PM	98	550	550	A
IMP-H	Sked 2Q72	137.920	30F9/12	PCM/PM	28.5	225,000	225,000	B
ISIS-A	1/30/69	137.950	A0/0.1	CW	88.5	3,517	574	C
SSS-A	Sked 3Q71	137.950	A0/3F9/90F9	CW, PCM/PM or FM/PM	2.9	31,251	222	D
ISIS-B	4/1/71	137.950	A0/0.1	CW	88.2	1,424	1,355	C
IMP-J	Sked 2Q73	137.980	30F9/12	PCM/PM	28.5	250,000	200,000	B

REMARKS:

A. Continuous radiation of CW beacon or narrowband telemetry, with wideband telemetry on command, is normal mode of operation. Beacon and narrowband telemetry can be commanded on/off as required.

B. Continuous radiation is normal mode of operation, but signal can be commanded on/off as required.

C. Experimental beacon; transmits only on command for DRTE tracking.

D. Normal mode of operation is transmission of wideband telemetry on command with backup narrowband telemetry or CW beacon only if required.

Table B-3. Potential 148.980-MHz Conflicts

Spacecraft Mission	Launch Date	Frequency	System	Conflicting Address or Subcarrier	Incl	Apogee	Perigee	Remarks
OGO-3	(1966 49A)	148.98	PCM & T	None	75.8	105,914	16,428	A
GEOS-2	(1968 02A)	148.98	T	None	105.8	1,573	1,081	
OGO-5	(1968 14A)	148.98	PCM & T	None	54	120,666	26,405	A
RAE-A	(1968 55A)	148.98	T	None	120.9	5,859	5,845	
OGO-6	(1969 51A)	148.98	PCM & T	None	82	992	401	A
PAC-A	(1969 68B)	148.98	T	None	33	515	461	
SERT-2	(1970 09A)	148.98	T	None	99.1	1,048	1,042	
SSS-A	(Sked 3Q71)	148.98	PCM & T		2.9	31,251	222	A
SAS-1	(1970 107A)	148.98	PCM	None	3	566	529	
SAS-B	(Sked 4Q71)	148.98	PCM	None	2.9	555	555	
IMP-H	(Sked 2Q72)	148.98	PCM & T	None	28.5	225,000	225,000	A
IMP-J	(Sked 2Q73)	148.98	PCM & T	None	28.5	250,000	200,000	A
RAE-B	(Sked 2Q73)	148.98	T	None	28	384,000	384,000	B

REMARKS: A. PCM Primary system with backup tone system.

B. RAE-B planned selenocentric orbit elements include 50° inclination, 1100 km apogee and perigee.

APPENDIX C

INITIAL OPERATIONS AND CONTINGENCY PLANS

APPENDIX C

INITIAL OPERATIONS AND CONTINGENCY PLANS

This appendix contains tables which outline the procedures to be used during initial SSS-A operations, and contingency plans to be followed during abnormal spacecraft operations. Commands will only be sent when directed by MSOCC. The information presented in this appendix is to be used for reference only and is subject to change.

Table C-1
Operations and Contingency Plans for Orbit 0

Station	Profile	T+Time (hr:min)	Max El (Deg)	Command			Action or Remarks
				PCM	Tone	Literal	
SEYCHL	AOS Hor	00:3	55				Report 136.830-MHz AOS. Record PCM TLM data and AGC signals on analog tape.
		00:7					Report Az/El just before expected fourth stage ignition.
		00:8					Report Az/El just after expected orbital injection.
	LOS Mask Hor	00:9 00:11					Report 136.830-MHz LOS.
							Voice reports from SEYCHL on the above action will be relayed to Sunnyvale AFB, California and by commercial means from there to OPSCON, GSFC.
							NOTE: No tracking required.

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Table C-2
Operations and Contingency Plans for Orbit 0/1

Station	Profile	T+Time (hr:min)	Max El (Deg)	Command			Action or Remarks
				PCM	Tone	Literal	
CARVON	AOS Hor Mask	 00:15 00:16 01:00	25				Report 136.830-MHz AOS on down-link of R&RR system. Record PCM TLM data and AGC signals on analog tape. Terminate support at MSOCC direction (approximately T+60). <u>NOTE:</u> X-Y tracking required.
ORORAL	AOS Hor Mask	 00:23 00:25	36				Report 136.830-MHz and 137.950-MHz AOS. Verify PCM data on 136.830 MHz and analog data on 137.950 MHz. Report signal strengths and carrier power drops as required during pass. Record PCM data (136.830 MHz) and analog data (137.950 MHz). Transmit PCM data to MSOCC/DRL via DTS. Transmit redundant PCM data to MSOCC on 202 data modem as backup to the DTS data. MSOCC will send the PCM data from the DTS decoder output to SIL and standby to send OA data to 360/95 computer. DRL will record PCM data during pass and process experiment data in near-real time. SIL will process experiment data in real-time.

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Table C-2
Operations and Contingency Plans for Orbit 0/1 (Cont)

Station	Profile	T+Time (hr:min)	Max El (Deg)	Command			Action or Remarks
				PCM	Tone	Literal	
ORORAL (Cont)			36	Contingency Plan for Negative AOS (Use High Power CMD XMTR)			
				022	CAB	DATA XMTR ON	Verify that the TLM system is in the accelerated subcom mode (ASM) send command 104 if necessary. Verify experiment buss is off. If experiment buss is on, discontinue contingency plan and proceed to command 100.
				067	—	MGTMTR EXP OFF	
				061	—	AC EL FLDS EXP OFF	
				046	—	DC EL FLDS EXP OFF	
				032	—	SS EL DET EXP OFF	
				034	—	SS PTN DET EXP OFF	
				016	—	SCADS OFF	
				052	—	CHNLTRN EXP OFF	
				073	—	EXP XMTR OFF	
				116	ABA	EXPS ABL	Verify that all experiments are off.
				072	—	EXP XMTR ON	If the data transmitter is turned off (LOS) after sending one of these commands, proceed as follows:
				066	BCB	MGTMTR EXP ON	
				060	—	AC EL FLDS EXP ON	
				076	—	DC EL FLDS EXP ON	

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Table C-2
Operations and Contingency Plans for Orbit 0/1 (Cont)

Station	Profile	T+Time (hr:min)	Max El (Deg)	Command			Action or Remarks
				PCM	Tone	Literal	
ORORAL (Cont)			36	022	—	DATA XMTR ON	Command the offending experiment off (i.e., the command that caused the data XMTR LOS).
				116	ABA	EXPS ABL	
		TBD		100	—	DATA MODE	Command time approximately AOS +1 minute. MSOCC will send OA data to 360/95. ORORAL report readout from A-34 (All ZEROS indicates separation) and B-45, bit 5 (ZERO indicates disarmed). ORORAL will read AGC nulls from channels A and B of 136.830-MHz TLM rcvr and estimate spin rate/period and report same to MSOCC. Strip chart recording of AGC nulls are to be sent to MSOCC. MSOCC will check separation, spin-rate, and sun angle.
				Contingency Plan for Negative Separation/Despin (Use High Power CMD XMTR)			
				104	—	ACCL SUBCOM MODE	
				056	—	ARM SEP DSPN	
				002	—	SEPARAT	
				057	—	DISARM SEP DSPN	
		TBD		104	—	ACCL SUBCOM MODE	Command Time approximately AOS +10 minutes. MSOCC will stop sending OA data to 360/95. MSOCC

Table C-2
Operations and Contingency Plans for Orbit 0/1 (Cont)

Station	Profile	T+Time (hr:min)	Max El (Deg)	Command			Action or Remarks
				PCM	Tone	Literal	
ORORAL (Cont)		TBD	36	104	—	ACCL SUBCOM MODE	will verify spacecraft launch configuration and spacecraft flight program 502I. Project personnel at MSOCC will check power and thermal parameters.
		≈01:00		035	—	ASCS ATT PLUS	Terminate PCM data transmission via 202 modem.
				115	CBA	ASCS OFF	
				063	—	ASCS ATT MINUS	
				115	CBA	ASCS OFF	
				017	—	ASCS SPIN UP	
				025	—	ASCS SPIN DOWN	
				115	CBA	ASCS OFF	
				106	ACB	ASCS DRCT ATT ON	
				115	CBA	ASCS OFF	
				100	—	DATA MODE	
		02:11		055	—	MGTMTR FLX H/L RNG	ORORAL and MSOCC will verify command. (B-41, bit 1 = 1; high range).
		06:24		055	—	MGTMTR FLX H/L RNG	ORORAL and MSOCC will verify command. (B-41, bit 1 = 0; low range).

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Table C-2
Operations and Contingency Plans for Orbit 0/1 (Cont)

Station	Profile	T+Time (hr:min)	Max El (Deg)	Command			Action or Remarks
				PCM	Tone	Literal	
ORORAL (Cont)	LOS Mask Hor	 07:48 07:55	36				Report 136.830-MHz and 137.950-MHz LOS. NOTES: 1. All commands will be sent only when directed by MSOCC. 2. The spacecraft will be launched with the TLM system in the ASM with flight program 502I which will automatically switch the TLM system into the data mode if not successfully commanded sooner. 3. Minitrack operations and X-Y tracking on 137.950-MHz required.

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Table C-3
Operations and Contingency Plans for Orbit 1

Station	Profile	T+Time (hr:min)	Max El (Deg)	Command			Action or Remarks
				PCM	Tone	Literal	
ALASKA	AOS		12				Report 136.830-MHz and 137.950-MHz AOS.
	Hor	01:09					
	Mask	01:50					Record PCM TLM data (136.830 MHz).
		04:13					Report look angles and time of maximum elevation.
		TBD					Terminate support at MSOCC direction (sometime after maximum elevation).
							NOTE: X-Y tracking required.
	AOS		42				Report 136.830-MHz and 137.950-MHz AOS.
	Hor	08:18					
	Mask	08:22					Record PCM TLM data (136.830 MHz).
QUITOE			42				Transmit PCM TLM data to MSOCC via DTS. MSOCC will transmit OA data to 360/95 computer.
							No commands are anticipated, but QUITOE will be prepared for command operations if required. All commands will be sent only when directed by MSOCC.

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Table C-3
Operations and Contingency Plans for Orbit 1 (Cont)

Station	Profile	T+Time (hr:min)	Max El (deg)	Command			Action or Remarks
				PCM	Tone	Literal	
QUITOE (Cont)	LOS Mask Hor	 08:27 08:28					Report of 136.830-MHz and 137.950-MHz LOS. NOTE: Minitrack operations on 137.950 MHz required.

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Table C-4
Operations and Contingency Plans for Orbit 1/2

Station	Profile	T+Time (hr:min)	Max El (Deg)	Command PCM	Command Tone	Command Literal	Action or Remarks
JOBURG	AOS Mask	08:42	48				Report 136.830-MHz and 137.950-MHz AOS.
							Record PCM TLM data (136.830 MHz) and analog data (137.950 MHz).
							Transmit PCM data to MSOCC/DRL via DTS. MSOCC will send the PCM data from the DTS decoder output to SIL and send OA data to 360/95 as required.
							DRL and SIL will process experiment data.
							MSOCC will verify San Marco Range acquired the spacecraft.
		TBD		033	BAB	SS PTN DET EXP ON	Use the tone-sequential command BAB.
		TBD		023	—	SS EL DET EXP ON	MSOCC check experiment status as follows: (1) Determine spacecraft current (B-5) prior to sending command 023 and after sending command 023. Experiment current should be approximately 30 ma.

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Table C-4
Operations and Contingency Plans for Orbit 1/2 (Cont)

Station	Profile	T+Time (hr:min)	Max El (Deg)	Command			Action or Remarks
				PCM	Tone	Literal	
JOBURG (Cont)			48				(2) Check the following parameters A-60 2.40-2.51 (2.46 nom) A-9 2.40-2.51 (2.46 nom) A-10 2.25-2.33 (2.29 nom) A-11 4.15-4.35 (4.30 nom) A-12 0-0 A-13 0-0 A-14 $7^{o}-27^{o}$ (17^{o} nom)
		10:31		055	—	MGTMTR FLX H/L RNG	JOBURG and MSOCC verify. (B-41, bit 1 = 1; high range).
		14:44		055	—	MGTMTR FLX H/L RNG	JOBURG and MSOCC verify. (B-41, bit 1 = 0; low range).
	LOS	16:19					Report 136.830-MHz and 137.950-MHz LOS. NOTES: 1. All commands will be as directed by MSOCC. 2. Minitrack operations on 137.950 MHz required.
MADGAR	AOS Mask LOS	 08:46 16:27	62				Minitrack operations on 137.950 required.

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Table C-5
Operations and Contingency Plans for Orbit 2

Station	Profile	T+Time (hr:min)	Max El (Deg)	Command			Action or Remarks
				PCM	Tone	Literal	
QUITOE	AOS	17:05	86				Report 136.830-MHz AOS. Record PCM TLM data.
							Transmit PCM data to MSOCC via DTS.
							MSOCC will send OA data to 360/95 computer.
		17:20					Terminate support at direction of MSOCC.
							<u>NOTE:</u> Minitrack operations on 137.950 MHz required.

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Table C-6
Operations and Contingency Plans for Orbit 2/3

Station	Profile	T+Time (hr:min)	Max El (Deg)	Command			Action or Remarks
				PCM	Tone	Literal	
ROSMAN	AOS	17:07	51				Report 136.830-MHz and 137.950-MHz AOS.
							Record PCM TLM data (136.830 MHz) and wideband analog data (137.950 MHz).
		17:20					Transmit PCM data to MSOCC/DRL via DTS. Transmit 30 minutes of wideband analog data to MSOCC via microwave.
							MSOCC will send the PCM data from the DTS decoder output to SIL.
							DRL and SIL will process PCM experiment data.
							MSOCC will demodulate wideband analog data.
							MSOCC will configure for command operations thru ROSMAN.
		TBD		001		DC EL FLDS PLRT	MSOCC will check A-2 status 0.60 (±0.05) = unsat., plate off 1.13 (±0.05) = unsat., plate on 2.95 (±0.05) = sat., plate off 3.50 (±0.05) = sat., plate on. *
		TBD		—	—		MSOCC will load spare cell in flight PGM 502I with ZEROS by sending command for OBC location 057 (octal). Standby to load new flight program.
		TBD					Terminate DTS command link.
							*High gain, negative mode

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Table C-6
Operations and Contingency Plans for Orbit 2/3 (Cont)

Station	Profile	T+Time (hr:min)	Max El (Deg)	Command			Action or Remarks
				PCM	Tone	Literal	
ROSMAN (Cont)		18:51	51	055	—	MGTMTR FLX H/L RNG	ROSMAN verify. (B-41, bit 1 = 1; high range).
		23:04		055	—	MGTMTR FLX H/L RNG	ROSMAN verify. (B-41, bit 1 = 0; low range).
	LOS	24:43					Report 136.830-MHz and 137.950-MHz LOS. NOTES: 1. All commands will be as directed by MSOCC. 2. No tracking required.
FTMYRS	AOS LOS	17:06 24:45	61				Minitrack operations on 137.950 MHz required.
SNTAGO	AOS LOS	17:09 24:47	46				Minitrack operations on 137.950 MHz required.

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